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FIFTY YEARS OF THE SCIENTIFIC-TECHNICAL SOCIETY OF FERROUS METALLURGY

D. A. Smolyarenko

Translated from Metallurg, No. 11, pp. 1-2, November, 1960

In 1960 the Scientific-Technical Society of Ferrous Metallurgy completes the fiftieth year of its existence.

In 1908, upon the initiative of a group of metallurgists in St. Petersburg, a Committee on the Organization of the Russian Metallurgical Society was formed composed of the outstanding metallurgists and physical metallurgists A. A. Baikov, N. I. Belyaev, V. E. Grum-Grzhimailo, M. A. Pavlov, and others.

As a result of the great work done by the Organization Committee, the Russian Metallurgical Society was recorded in the register of societies of the city of St. Petersburg by the St. Petersburg Special Municipal Office for the Business of Societies and its charter was approved.

The first paragraph of the charter stated:

"The Russian Metallurgy Society, founded in the city of St. Petersburg, has the purpose of contributing to the success of all branches of metallurgy and to the diffusion of metallurgical knowledge. For this the Society calls conferences, publishes a journal, arranges public lectures and readings and, in observance of the rules established that respect, organizes scientific expeditions and congresses, and with the proper authorization arranges exhibitions, laboratories and experimental stations, can open technical consultation bureaus and in general search for measures corresponding to the scientific and technical purposes of the Society. The region of activity of the Society is the Russian Empire."

After the charter was approved in February, 1910, the first meeting of the members of the Society, consisting of 233 men, was held in St. Petersburg, where the Presidium and Council of the Society were elected. D. K. Chernov was elected honory chairman, A. A. Baikov secretary, and M. A. Pavlov editor of the journal.

The organization of the Russian Metallurgical Society belonged to a period of industrial development in tsarist Russian when an enormous amount of metal was required by railroad builders for the manufacture of rails, steam engines, and railroad cars.

In accordance with the charter of the Metallurgical Society a journal was founded, the Journal of the Russian Metallurgical Society (ZhRMO), in which the various investigations carried out by scientists were made known, and this contributed to the development of metallurgy and to the diffusion of metallurgical knowledge. The journal was published six times a year with a total volume of 85-95 sheets. The first printing was 525 copies, and this was increased to 750 in 1914.

In spite of all the efforts of the scholars, researchers, and engineers united by the Society, Russian capitalism could not provide a growth of ferrous metallurgy which could become the basis of the broad economic growth of Russia. Prerevolutionary Russia was in fifth place in the world in steel smelting.

The membership of the Society grew from year to year. In 1910 it was 267 members, and on January 1, 1916 it was 812 men. The membership fee was six rubles per year. During World War I the Society increased its activities and took part in direct aid to industry. In 1915 courses were organized to prepare instructors in the thermal processing of steel for shells, in which lectures were given by the most eminent metallurgists and metallurgical physicists, such as A. A. Baikov, A. L. Baboshin, V. E. Grum-Grzhimailo, and others.

The Journal of the Russian Metallurgical Society was suspended in 1916, reinstated in 1925,and dicontinued in 1928.

On February 4, 1927 the National Commissariat of Internal Affairs approved a new charter of the Russian Metallurgical Society, point 1 of which stated:

"The Russian Metallurgical Society, founded in 1910 in Leningrad, has the purposes of: uniting persons working scientifically or in practice in the field of metallurgy, and likewise the scientific working-out of problems relating to this area; the diffusion of pertinent information and the arousal of interest in the tasks of the Society in the social environment; the performance of scientific and technical work assigned in the area of metallurgy and the metal-working industry; consultation on problems of governmental institutions and individual enterprises and the diffusion of metallurgical knowledge."

As a result of the policies of our Party during the years of Soviet power,ferrous metallurgy began to grow rapidly and considerably surpassed many capitalistic countries in its rate of growth. The great lag of Russia behind the capitalistic states in the size of ferrous metal production,which existed before the revolution,has been overcome. The Soviet Union at the present time occupies first place in Europe and second in the world in the production of cast iron, steel,and rolled iron.

An overwhelming majority of the members of the Society are actively engaged in the work of newly created governmental Soviet organs and social organizations. The Soviet power, as has no other power in the world, has permitted unlimited possibilites to scientists and engineers for creative work.

On October 19, 1931 the Central Committee of the Communist Party of the Soviet Union issued a decree on the organization of scientific engineering-technical societies in the USSR. The Scientific Engineering-Technical Society of Metallutgists which was created expanded its activity in extending aid in raising the qualifications of engineering-technical workers (courses, lectures, reports) and attracted them to the solution of scientific-technical problems. For this purpose, in addition to the theoretical working up of problems by groups, experimental work and research were conducted in factories and laboratory scientific-research and planning institutes, with the participation of members of the All-Union Scientific Engineering-Technical Society of Metallurgists (VNITOM).

In the period from 1931-1935 the VNITOM creatively worked out a number of theoretical problems of metallurgy and metallurgical physics.

For purposes of the broad scientific-technical diffusion and the exchange of scientific and production experience the Society of Metallurgists has at all times carried out vast work on the basic problems of metallurgical production.

In accordance with decisions of the Central Committee of the Communist Party of the Soviet Union and the All-Union Central Council of Trade Unions, scientific engineering-technical societies were reorganized in 1955 into massive scientific-technical societies governed by the trade unions, for the purpose of further developing their attraction to creative participation in solving the problems of socialist building.

In the practical realm of activity of the Scientific-Technical Society, problems in the development of ferrous metallurgy, fulfilling the productive operating plans of the enterprises,and setting up a long-range plan for the growth of ferrous metallurgy receive primary attention.

Since the reorganization of control of the industry in 1957, the Scientific-Technical Society of Ferrous Metallurgy (NTO ChM) has been carrying out much work on the exchange of experience. All-Union conferences of the basic branches of ferrous metallurgy, which are held regularly, always evoke warm discussions, creative disputes, and a widespread exchange of opinions. The business encounters at such conferences and meetings of the country's metallurgists always help in finding solutions more quickly in the struggle for technical progress.

As a result of the joint work of members of the society — scientists and factory engineers — on the study and generalization of innovators in production, a number of recommendations have been worked out and distributed to all plants in the country — contributing increase in the durability of open-hearth furnaces and mechanization of their charging, increase in the annual output of steel,and the introduction of rapid rolling with minimum losses.

In the primary organizations of the Society there has been extensive development of socialist competition for successful accomplishment of the basic economic task, to catch up with and surpass the most developed

capitalistic countries in production per capita. Socialist pledges directed toward fulfillment in advance of the Seven Year Plan have been made by the primary organizations of the Society in many enterprises, among them the "Elektrostal'" plant (Comrade Kultygin, chairman of the council), the "Zaporozhstal'" plant (Comrade Soroko, chairman of the council), the Kuznetsk Metallurgical Combine (Comrade Borodulin, chairman of the council), the Nizhni Tagil' Metallurgical Combine (Comrade Makaev, chairman of the council), the Serov plant (Comrade Kadrov, chairman of the council), and others.

The Society depends to a considerable degree on the creative activity of the branch scientific-technical sections in its operations.

Eighteen branch sections operate in affiliation with the Central Administration of the Society, each of which usually carries out, in the course of a year, about six scientific-technical measures which encompass a large number of members of the Society.

Some especially active members of the Society are the Lenin Prize winners I. I. Korobov and G. G. Oreshkin, B. N. Zherebin, A. F. Zakharov, Ya. P. Kulikov, M. M. Privalov, L. S. Klimasenko, I. G. Mogilevtsev, F. D. Voronov, the Lenin Prize winner G. V. Gurskii, D. I. Garbielyan, N. V. Kashakashvili, B. I. Kochurin, and many others.

The editorial-publishing council of the Society systematically publishes the Proceedings of the Society. Thus, during 1955-1960, material was published on conferences of blast-furnace workers, steel smelters, and workers in the refractory and coal-tar chemical industries. Papers by members of the Society are published in its Proceedings; separate brochures on the exchange of experience and materials for the operation of the interplant schools are also issued.

At meetings of the council there are regular discussions of thematic plans; the date of issuance of the Proceedings and other literature of the central, republican, and regional administrations are determined and manuscripts are examined as well as materials which the councils of the primary organizations will publish.

The July, 1960 Plenum of the Central Committee of the Communist Party of the Soviet Union, among other very important problems, considered also the problem of qualitative indices. The Plenum pointed out the need to raise the responsibility of the management of enterprises, of planning and scientific establishments, and of all engineering-technical workers for raising the qualitative level of plans, designs of machinery, and equipment for improvement of the quality of products.

In this great work, which embraces science as well as industry, it is impossible to set to one side the decision of a number of theoretical aspects associated with a many-sided evaluation of metal production. For the time being we have serious shortcomings in method in evaluating the quality of articles, and we have no scientific-research work on finding comparable criteria for the quality of articles.

The absence of numerical or even clearly comparable indices of the quality of articles hampers the operations of many enterprises and design offices. The working out of both general and particular problems in the evaluation of the quality of metal production, the elimination of the aspects of this problem which are the most essential for the national economy – all this is exceptionally important at the present time.

Everyone agrees that increasing the operating life of metal products is practically equal to increasing the production of metal without increasing operating capacities. The Scientific-Technical Society of Ferrous Metallurgy, acting with the factory collectives and scientific-research institutes, is taking steps to raise the general level of the quality of production, so that the product issued will meet higher specifications for quality in comparison with the low limits established by the State Standards and technical specifications, and steps to increase the uniformity and assure constancy of the quality of production. It is necessary to assure constancy in the quality of all raw materials: in blast-furnace production, the size preparation of ore and strict observation of constancy in its chemical composition, constancy in the quantity and temperature of the blast; in steel smelting production, constancy in the quality of all charge materials, compulsory maintenance of the thermal regime, constancy for a given type of steel, etc.

In the nationwide struggle to fulfill the Seven Year Plan, the spreading of information about the achievements of science and technique, progressive technology, advanced working methods, and the organization of production is acquiring special importance. The members of the Society must make full utilization of what has been produced as a result of the creative efforts of workers, foremen, engineers, scientists, and designers.

The growing membership of the Society, now numbering more than 53,000 men, and broadly expanding scientific- research and organizational work are permitting a more rapid and more successful solution of the problems set before the metallurgists of this country by the Twenty-First Congress of the Communist Party of the Soviet Union.

THE AUTOMATION OF METALLURGICAL PLANTS – AN URGENT TASK OF OUR TIME

K. P. Kostenetskii

State Institute for the Design and Planning of Metallurgical Plants
Translated from Metallurg, No. 11, pp. 3-5, November, 1960

The ultimate purpose of automation in any branch of industry is the automation of entire enterprises, the creation of automated plants. The first planned considerations for automated metallurgical plants were worked out in 1960 by the Mechanization Sector of the State Institute for the Design and Planning of Metallurgical Plants. Three very important aspects of total-factory automation were provided for.

1. The creation of the technological fundamentals of automation, that is, those technological processes and aggregates which would be subject to automation to the greatest degree.

2. The creation of a system of automated transportation.

3. The creation of the cybernetic fundamentals of automation, that is, the automatics of measurements, control,and regulation of individual electric drives and mechanisms; the arrangement of computers for the purpose of automated regulation of individual objects, plants,and factories as a whole.

Many specialists think that only continuous processes are subject to full automation. Metallurgical processes meet the condition of continuity to a great extent. Therefore, the introduction of continuous coking acquires great important in total-factory automation, as do the use of continuously operating agglomerate plants and equipment for the straight-line production of iron, the working-out of continuous steel smelting processes, the application of continuous iron rolling mills, the continuous pouring of steel, etc.

But, the creation of complex automated enterprises is already needed today. Reference to the possibility of creating automated plants only on the basis of continuously operating aggregate leads to the fact that the solution of problems in total-factory automation is,as it were,postponed for an indefinite period. Therefore, the creation of automated factories requires automation of existing facilities. It is all the more important that a considerable portion of the metallurgical plants are equipped with batch-operating aggregates. Consequently, even if a new plant were successfully built for continuously operating aggregates,the need to solve the problems of automating existing metallurgical plants would not be excluded. If then it proves possible in the process of planning a construction to change some aggregates so that they can operated continuously, this will lighten the task of continuous automation of the plant.

Providing for Uniformity of the Process

The most important condition in the introduction of automation is the preparation of charges which provide the most uniform course of the technological processes.

Many agglomerate-concentrating plants have been built in recent years. In many plants the blast-furnaces have changed over to operating with flux agglomerates. Much work is being done on the sintering of ores. It is quite important to reduce the quantity of the components in the charge and work must therefore be done on the creation of unit charges.

The quality of the agglomerate produced at the present time often leaves something to be desired. The high fines content in the agglomerate sharply reduces the productivity of the furnaces and complicates automation. Fractional charging of coke and agglomerate improves the operation of blast-furnaces but this measure must be considered as temporary, although quite important. It is necessary to obtain improvement in the quality of coke and agglomerate directly during their production. Another problem is the creation of ore-neutralizing machinery. The first such machine, made by the South Urals Heavy Machinery Plant, with a productivity of 350 m^3/hour, should be completed this year. It can be hoped that it will find wide application in metallurgical plants.

Basic attention must be devoted to the preparation of charges for steel smelting aggregates, most of all to the preparation of scrap of defined fractions, its grading and piling. According to the considerations of the State Institute for the Design and Planning of Metallurgical Plants, the scrap-grading bases and charging yards are to be converted into special blocks of preparatory plants in steel smelting production, wherein the process of grading scrap provides the equipment of continuously operating aggregates with the utilization of large-scale piling presses, alligator shears, etc.

The introduction of automation requires a reexamination of problems in the specialization and coordination of production. It is simpler to automate production with a minimum of nomenclatures of production, with a minimum of departures from the fundamental technological process, with the minimum of auxiliary establishments. For universal factories issuing various products, automation at the first stage is undesirable, generally speaking. It is necessary to simplify the nomenclature of cast iron and steel as well as the profiles of cast iron.

Factory Structure

Two variants of the automated factory have been examined in the planning considerations: with existing aggregates which have large productivity (Fig.1*) and with the utilization of new technological processes (Fig.2*). In particular, consideration has been given to variations in the construction of blast-furnaces with a useful volume of up to 3000 m^3 utilizing natural gas, oxygen, increased pressure, and high-temperature blasting. In doing this, an examination was made of variations of the conversion of blast-furnaces into continuously operating aggregates with the utilization for this purpose of induction stoppers and winches, and likewise with charging by conveyer directly into the charge hole of the blast-furnace.

It is proposed to produce steel in open hearth furnaces with a charge of up to 1000 tons and converters with a capacity of up to 300 tons. It is proposed to build a special plant for preparation of the charges. A variation of preliminary preheating of the friable part of the charge and of the liquid cast iron in cyclones is possible, with use of a conveyer from the charge-preparing plant directly to the steel-smelting aggregate.

In planning the plants an effort is being made toward maximum utilization of the principles of transition to a continuous steel smelting process (preliminary preheating of charges in cyclones, bell-type furnaces, preliminary smelting of ores and fluxes, etc.). Consideration is also being given to the problem of desilicizing cast iron in mixers or tubes for its transportation, as well as vacuum smelting of steel.

Along with the continuous pouring of steel, the pouring of steel into conveyers and molds is also being provided for by planning considerations.

It is proposed to set up shape and sheet mills in rolling mill plants. On the basis of the creation of the rolling mills, the principles are being established for continuous technological processes, endless rolled iron, and the purification of blooms on stream, and provision has been made for the use of straight-through preheating furnaces, higher rates of iron rolling, and the complete automation and mechanization of auxiliary operations up to the finishing and packaging of the product.

If equipment for continuous steelmaking cannot supply the rolling mills with intermediates, provision is being made for the construction of new automated blooming mills of types 1300-1350 for rolling of assorted ingots weighing up to ten tons and new slab mills of type 1250 for rolling ingots weighing up to 35 tons.

Transportation

New systems of automated transportation are being set up as the basis of the automated factory. At the present time there are practically no automated metallurgical aggregates. By the terms "automation of blast-furnaces" and "automation of steelmaking furnaces" is understood the automation of separate processes or parts

* See centerfold.

of processes. If the supplying of heat, gas, electricity, water,and other components is readily subjected to automation, the supplying of the charge, the removal of the product of the basic metallurgical processes,and loading and unloading operations are still so inadequately automated that the automation of production cannot be done completely. That is, the automation of transportation is the most important factor in the introduction of total-factory automation. The role and significance of industrial transportation is very great, but insufficiently appreciated. It is the accepted thing to consider that internal transport and warehouse equipment, including railroads under the plant roof and special pouring cranes, bunker trestles,and many other pieces of equipment are objects of basic technology. Just the same, all the expenses of transportation within the plant and in the aggregate relate to expenses for basic technology. If one examines just what the role of industrial transportation actually is in metallurgy, it turns out that up to 30-40% of the capital expenditures are directly or indirectly connected with transportation expenses. In expenses of reduction,up to 35-40% are in transportation, and up to 35-50% of the entire personnel of the enterprise are occupied in transportation.

Thus, the problem of transportation is the most important problem of a large-scale metallurgical plant.

At the present time, railroad transportation is very widely distributed in plants; a great many people work on them and as a rule the railroads require the use of crane equipment in plants, and this in turn complicates the design of plants and their mechanization.

Complex mechanization built on existing forms of transportation is very complicated, cumbersome,and not subject to automation to the fullest degree. In a number of cases, railroad transportation, on the basis of its productivity, is not coping presently with the tasks facing it. Thus, the high productivity of blast-furnaces requires large pouring fronts, which is hampered by separation of the chutes. In this section, it is necessary at the present time to go over to the use of dumping chutes with tumblers, which is practically a transition to conveyerization of the transportation.

The intensification of steelmaking production poses a severe problem as regards the steel pouring sections. For practical purposes neither further increase in the capacity of the pouring cranes nor the building of additional pouring sections on both sides of existing plants (according to the latest plans of the State Institute for the Design and Planning of Metallurgical Plants), or the breaking up of a large plant into a number of plants (a variation of the block-island disposition of furnaces) are solving the problem of steelmaking. All the growing intensification of steelmaking production requires a radical change in the technology of pouring steel, a rejection of the static pouring front,and a transition to a steel-pouring conveyer.

A conveyer is a stationary machine and in a number of cases is connected with technological aggregates, which simplifies the problems of loading and unloading, and the total solution of the plant also often eliminates additional reloading of materials. The use of conveyers simplifies transportation, eliminates numerous tracks and switches and means great breaks between plants, permits the use of large gradients, simplifies the plant decisions and general planning of the factory as a whole,and creates the conditions for the best organization of production. The use of conveyers raises labor productivity by ten or fifteen times. Capital expenditures for conveyer transport are 25 to 50% lower than on railroads, and operating expenses are reduced within the same limits.

Thus, in an automated factory provision is made for the creation of a complex automated conveyer system for the delivery of the charges and raw materials to the basic aggregates, and the use of conveyers for the delivery of coke and agglomerate directly to the charge hole of the blast-furnace with complete elimination of bunker trestles. Such a system is already being used abroad and completely justifies itself (France).

To transport liquid metal it is proposed to use induction pumps (Fig. 3) and special chutes for pipe. Induction pumps are already being used in industry in the transportation of readily smelted metals. Their operation is based on the use of a traveling magnetic field and induction currents induced by it in the liquid metal to create the conditions bringing the metal into forward motion. A special study has been made at the State Institute for the Design and Planning of Metallurgical Plants on the possibility of using induction pumps. The results of the investigation have been transmitted to the Central Scientific-Research Institute of Ferrous Metallurgy for the creation of test models. The use of new methods of transporting liquid metals will provide an important effect: numerous cranes used for the pouring of liquid cast iron will be eliminated, there will be no need to manufacture chutes, the ladles and ordinary pouring and mixing cranes will be eliminated, etc.

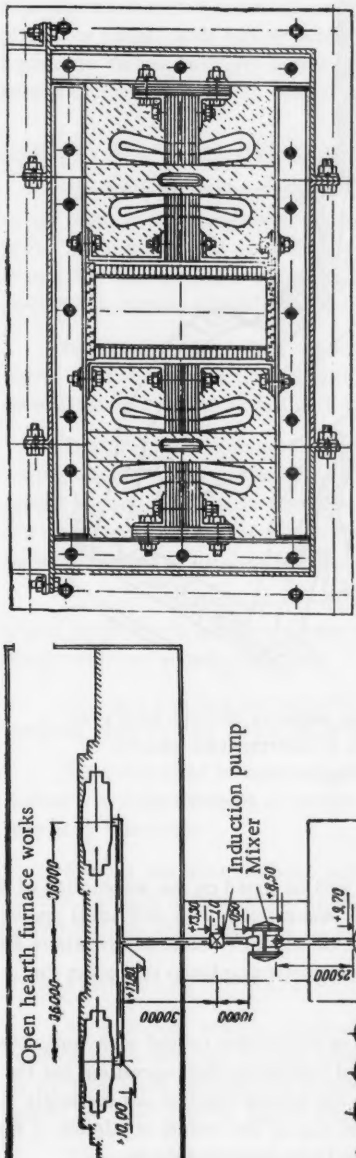

Fig. 3. Induction pumps for liquid crude iron. On the left: diagram of the transfer of iron to blast and open hearth furnaces.

For transportation of hot-liquid blast and steel-smelting slags,use is recommended of hydraulic hermetic equipment being developed at the present time by the Ukrainian State Institute for the Design and Planning of Building Materials Trust. It is proposed that immediately around blast-furnaces,and likewise under steelmaking aggregates,high-pressure hermetic installations will be set up, with a steam separator (Fig. 4) into which all the slag will be charged. After granulation it will be transferred by hydrotransport or conveyer systems to the shipping house. Variations are also being considered for the transportation of molten slag under pressure in pipes. Pneumatic transport is being specified for the removal of blast-furnace dust.

Automation of the charging of steelmaking aggregates is acquiring great importance. Converters to be charged by conveyer are already being provided for now. As for open hearth furnaces, new continuously operating charging machines will have to be created to solve this problem. In the work of the State Institute for the Design and Planning of Metallurgical Plants,first considerations have been given to the creation of machinery with a vibrating action and also to machinery with continuous molds while charges are fed into them by an extensive propelling conveyer.

In rolling mills a conveyer system of transport is provided for on the entire metalworking flow, and likewise for the removal of scrap, scale,and other waste.

A most important problem of the rolling mills is reducing the stocks of finished product, which now occupy 40-50% of the total area of a plant. Instead of small stocks around each mill it is proposed to create new large stocks of rolled iron with heavy-duty mechanization, which will free the plant from maintaining and shipping metal and allow it the possibility of its being occupied only with production.

To accomplish the new system of transport, it is proposed to use belt conveyers with rubber belts with a capacity of 50,000 tons per hour, and more, spacious conveyers with 10-ton containers and automatic loading and unloading of materials while in motion, propelling overhead conveyers with 10-ton containers, trolley conveyers for ingots weighing up to 35-40 tons, cableways with a capacity of 500 tons per hour, hydrotransport for the removal of various wastes, with an equipment capacity of 4-8 million tons per year, pneumatic transport for the movement of materials to distances up to 1 km, and many other special typesof conveyers and machinery. There will be extensive use of various kinds of motor trucks for the movement of individual small loads.

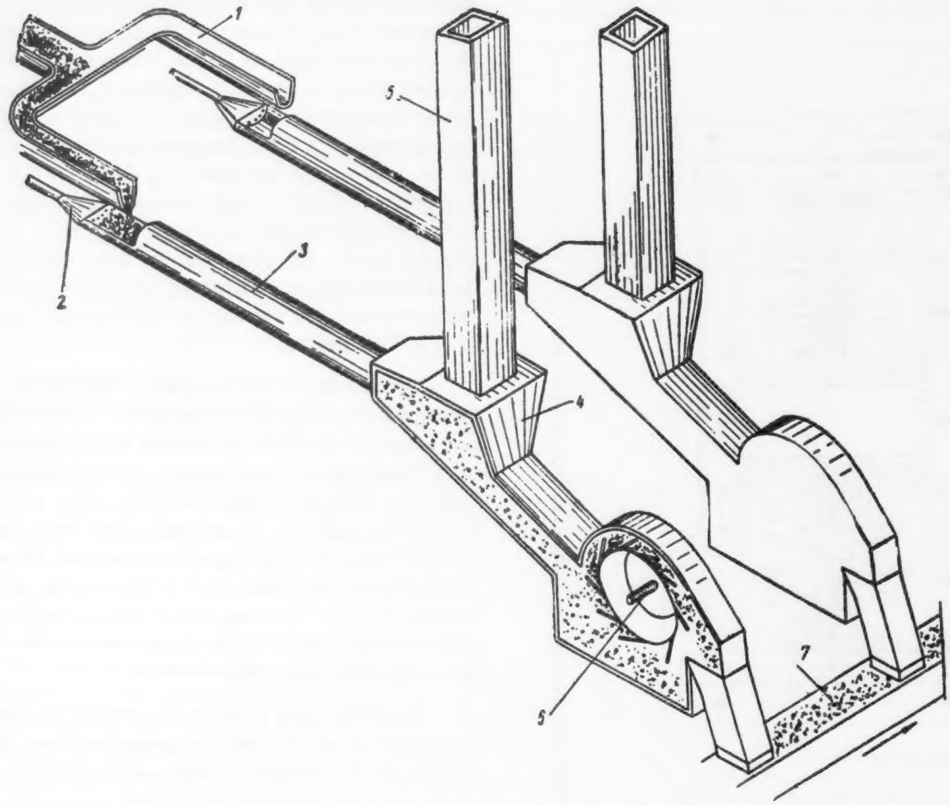

Fig. 4. Equipment for granulation and removal of blast-furnace slag, capacity 350,000 tons/year. 1) Overflow gutter; 2) hydromonitor buildup; 3) granulation channel; 4) intermediate bunker; 5) exhaust pipe; 6) dehydrating wheel; 7) conveyer for removal of slag.

Total-Factory Automatic Control

The automatic control of a metallurgical plant (cybernetic system) will be based on the automation of the individual aggregates and technological processes. The transition from the automation of an individual aggregate to the creation of a continuous line is linked, as a rule, with the creation of a new automatic regulator for all the lines as a whole, but this does not exclude, in a number of cases, automatic regulators to support the regime and operation of individual mechanisms.

The total-factory automatic control center, using the latest systems of contactless control with computers, should solve the problem not of the starting up of individual aggregates and regulating their operation, but the problems of regulating a balance in the factory as a whole, of distributing the various types of raw materials among the plants, of consumption of electricity, heat, gas, water, etc., and also of the mutual regulation of the regimes of the individual plants in order to maintain a single rhythm in the technological process.

Lack of uniformity of the charges and its improper disposition in sections of the blast-furnace, the possibility of a channeled operation, as well as other changes and the difficulties of rapid control of the quality of production — all this is complicating considerably the complete automation of metallurgical processes. It is therefore possible that instead of completely automated aggregates, for some time there will be use of a system of aggregates where many processes still will be regulated by highly qualified specialists — blast-furnaces operators or steel smelters. Automatic assistants will be able to come to their aid in control, in the solution of individual problems in production, etc.

The creation of automatic control systems will considerably accelerate work on the automation of representative metallurgical plants which is being done at the present time (the Magnitoforsk, Kuznetsk and Nizhnii Tagil' metallurgical combines, the Dzerzhinskii plant, etc.).

Thus, by an automated metallurgical plant, the creation of which is in our opinion an urgent task of the present time, we mean a plant in which the processes which consume the greatest amounts of labor will be basically mechanized and automated; in the end the processes of regulation and control will probably be accomplished by people with various automated means of assistance. There is no question that people will work in such a plant on various auxiliary operations (which will be mechanized as much as possible) and on maintenance work (which will be considerably simplified and consolidated).

General Plans for Automated Factories

The basic principle of the solution of a general plan for automated factories is to consider the entire factory as one plant in an arrangement of combined aggregates: a blast-furnace, a steel smelting aggregate, a rolling mill. According to this general plan a single outside railroad station is built for the receipt and shipment of materials. This station is under the control of the Ministry of Ways of Communication. All the warehouses of the plant and a number of auxiliary buildings are located near the railroad station.

Further along, in series, are located the coal-tar chemical plants, agglomerate factories, blast-furnace works, steel smelting works,and rolling mills of the factory; the interconnections between the warehouse and these plants are accomplished by means of controllers.

Thus, all the raw materials arriving at the metallurgical factory are discharged onto the tracks of the MWC sorting station, where car dumpers are set up in special areas. Unitary loads are discharged in these areas by special cranes. The finished product is loaded in another equipped area with a bunker trestle for the loading of free-flowing materials, slag for example, as well as railroad tracks with access to them along the entire loading front of descending mechanized monorail bogies or ordinary cranes for the loading of metal.

Coke and agglomerate are delivered by belt conveyers directly to the charge hole of the blast-furnace. Liquid crude iron is transferred over by induction pumps or temporarily by automated systems of railroad transport using transverse automatic bogies.

Slag and flue dust are removed by hydro- or pneumatic transport. The charge is supplied to the steel smelting plant by belt conveyers or a mono-transport for scrap transferable in containers.

Steel is melted in continuous melting machines or in molds on special conveyers. Steelmaking slag is removed by hydrotransport or various machines using special conveyers. In rolling mill plants all the metal is moved by conveyers.

Special attention has been devoted in the planning to the proximity of the main factories to one another (150-250 meters instead of 1.5 kilometers in existing plants). Thus, the factory should be planned as one plant with maximum cooperation of all the total-factory unit.

The Efficiency of Total-Factory Automation

An economic analysis made on the basis of the plans for the automated factory shows that its area can be reduced by 25-40%, the capital expenditures for transportation by 20%,and operating expenses for transportation by 30-50%; labor productivity on transportation can be raised by 500-800% and, when processes are fully automated, by 1000-1500%. On the whole,an automated factory will cost 20-25% less than an ordinary one.

The cost of conversion can be reduced by 40% and the number of workers in the plant by not less than two-thirds. Future improvement of automation will raise labor productivity still more.

* * *

The new positions stated in this article will be tested in the future, but one thing is important, that the problem of creating a new automated metallurgical plant, along with work on the automation of existing plants, requires steady attention at the present time, the mobilization of all resources, the cooperation of science and practice, and the creation of a definite plan of work. All scientific-research and planning work must proceed in one direction – toward the creation of fully automated factories. The State Scientific Technical Committee of

the USSR should create a commission on the development of the first automated metallurgical factory. This commission should coordinate the activities of all technological, planning and designing institutes, and plant producers in the solution of the general task.

MECHANIZATION AND AUTOMATION AT THE BLAST-FURNACE SHOP

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Magnitogorsk Metallurgical Combine

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Charging the Blast-Furnace

The blast-furnaces at the Magnitogorsk Metallurgical Combine are operated with two- or three-component charge consisting on the average of 93.4% self-smelting sinter and 6.6% ore and coke. The consumption of the remaining components per one ton of pig iron in 1959 constituted: limestone 1 kg, manganese ore 2 kg, metallic addition 12 kg (casting pig iron).

There is no ore yard at the shop. Sinter, iron ore, and flux are delivered by railroad to bins, each of 90 m^3 capacity. Coke is delivered to the coke bins from the coke and by-products plant by a system of conveyers.

18 hoppers with sinter are delivered to the stockhouse by electric cars and are discharged by two workers in 15-20 minutes without difficulty in any season of the year. For an increase in operating efficiency in this section, it is essential to increase the load-carrying capacity of the cars to 100 tons, to provide facilities for opening the hatch remotely from the stockhouse platform or from the control room of the electric car, and to mechanize the cleaning of the stockhouse.

At present the scale cars at the shop are being replaced by new systems of automatic charging. Two such systems have been adopted at the Combine.

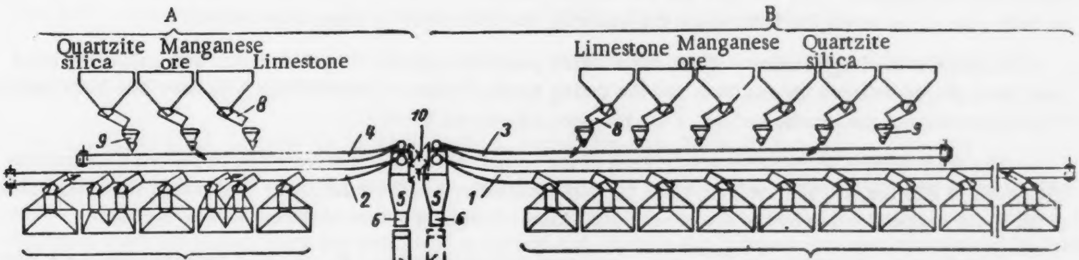

Fig. 1. Diagram showing the delivery of the charge to the skips. A) Spare equipment; B) operating equipment; 1),2) plate conveyors; 3), 4) belt conveyors; 5) scale hopper; 6) hopper shutoff; 7) skips; 8) vibrating feeders; 9) proportioning hoppers; 10) reversing chute.

The first system (Fig. 1) provides for the delivery of the coke, the sinter, the ore, and the additions in three streams. The sequence of operations for the coke delivery remained as before, i.e., bins, screen, and scale hopper. The sinter from the bins is discharged by vibrating feeders onto a plate conveyor and then into a scale hopper.

There are two plate conveyors. They are located on both sides of the skip pit and are switched in automatically in accordance with the program set up by the furnace foreman, who also determines how many and which vibrating feeders are to be switched in. The design data of the equipment is given below:

Weight of the equipment, ton	340
Weight of steel structure, ton	230

Plate conveyors for the sinter

Length, m	
On the east side	21.2
On the west side	60
Width, mm	1000
Speed, m/sec	0.47
Output, ton/hr	600
Motor capacity, kw	75

Belt conveyor for the ore and the additions

Length, m	
On the east side	22.5
On the west side	43.7
Width, mm	1000
Speed, m/sec	1.5
Motor capacity, kw	10

In the second system (Fig. 2) the sinter has to be discharged into two bins, each of 850 m^3 capacity, with drum feeders which discharge the sinter discharged on the vibrating screen. The screened sinter enters the scale hoppers and the fines are taken by the skip lift to the fines bins.

The ore and the additions are delivered from the bins to the proportioning hoppers, and then by a rubber conveyor to the weighing equipment. The coke is delivered from the bin by drum feeders to the scale hoppers via vibrating screens, and from the hoppers it travels by chute and then by conveyor to the skip. The coke fines are taken up by conventional hoist for coke fines or by a pneumatic transporter.

The replacement of a large number of small bins by a few large bins will make it possible to reduce the number of mechanisms; this is essential if the separation of small fractions of sinter is to be introduced.

Actually, the second system, which includes large bins for the sinter as well as small bins with plate conveyors, was adopted. The old coke bin was used as the large bin for the sinter, and the coke bins were placed on both sides of the sinter bin from which the material was discharged by three drum feeders.

Because of the large quantity of hot sinter which passes through the large bin, boxes with insulating brick have been placed between the concrete and the casing made of rails, and ventilating gaps have also been provided. The temperature of the outside surface of the bin does not exceed 20-30°C.

The drum feeders are water-cooled. Each of the feeders has separate drive. The two outside feeders discharge sinter into the left and the right scale hoppers separately, and the middle one can charge sinter into either of the scale hoppers in turn by the use of reversing chute. Weighing 8-tons of sinter takes 33 seconds.

Coke from the bins passes to the screen, conveyor and scale hopper. By means of the reversing chute either the left or the right scale hopper can be charged from any of the bins. This facility is made use of during repairs.

The sinter from one plant is charged into the large bin, and other sinter is delivered from small bins via the vibrating feeders to the plate conveyors. Two kinds of sinter can be added in any sequence in the 14 rounds in a cycle.

The raw ore and additions (limestone, manganese ore, open-hearth slag, cold sinter, etc.) are taken from the corresponding bins by the vibrating feeders and then by the conveyor to the left or the right scale hopper and discharged on top of the sinter.

The design data of the basic equipment for this system of charging is given below:

Weight of the equipment, ton	380
Weight of steel structure, ton	980
Plate conveyor for the sinter	
Length, m	60.05
Width, mm	1000
Speed, m/sec	0.5
Output, ton/hr	600
Motor capacity, kw	75
Belt conveyor for ore, additions and cold sinter	
Length, m	40
Width, mm	1000
Speed, m/sec	1.41
Motor capacity, kw	20
Belt conveyors for coke	
Length, m	15.2
Width, mm	1000
Speed, m/sec	1.41
Motor capacity, kw	14

The volume of the central bins could be considerably increased if the distance between the skips at the point at which they are loaded were increased.

It is essential to change to the method of tensometric weighing, which eliminates bulky weighing mechanisms and makes it possible to carry out the weighing operations directly in the skips, thus simplifying the charging system and permitting an increase in the capacity of the bins.

To screen the coke into two fractions with the object of the automatic control of coke particle size, it was proposed to divide the weighing hopper for the coke (Fig. 3) into two compartments. The +60 mm coke fraction from the upper screen falls into one compartment; and the 60-30 mm fractions falls into the other compartments. The coke is unloaded from each compartment in turn at intervals of a few seconds which makes it possible to fix the weight of the coke fractions.

At the charging sections one should also mechanize the cleaning of the stockhouse, the removal of materials from bins with coke fines, and automate the operation of testing the weighing equipment.

The application of remote recording and television will make it possible to improve the control of the operation of the charging mechanisms.

The Delivery of Steam into the Space between the Two Bells

Experience has shown that the continuous charging of steam into the space between the two bells does not ensure an absolute safety, accelerates the wear of the large bell rod, does not prevent the ejection of charge materials from the hopper when the small bell is opened, and weakens the compressive force between the bell and the hopper because of the increased pressure in the space between the two bells during the interval between the lowerings of the small bell.

The above shortcomings have been eliminated in the new method of steam charging. When the round is loaded, the outlet valve is open and therefore there is no pressure in the space between the two bells. Before the large bell is lowered, the steam valve (100 mm diameter) is opened and the space between the two bells is blown through with the steam for 10-15 seconds. Then the outlet valve is closed, the inlet valve is opened and the space between the two valves is filled with gas which establishes a pressure equal to the pressure under the bell. When the large bell is two-thirds open, the inlet and the steam valves are closed. When the large bell is closed, the outlet valve is again opened and the cycle starts again.

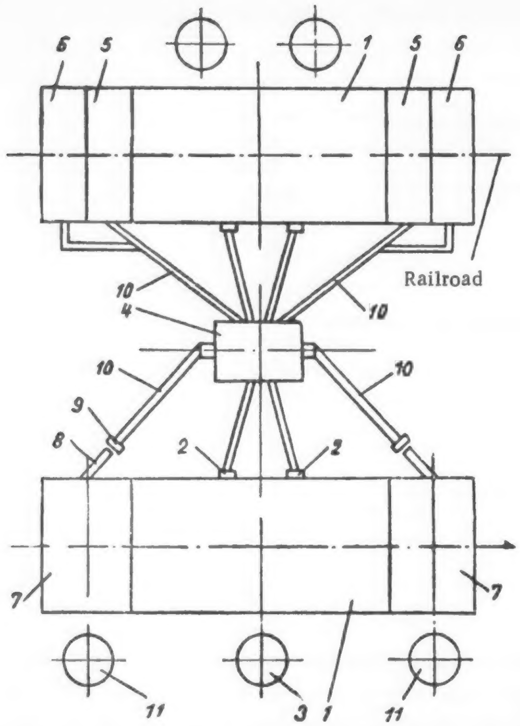

Fig. 2. Diagram showing the charging system of the blast-furnace: 1) Sinter bin; 2) sinter screens; 3) bins for sinter fines; 4) weighing equipment; 5) ore bins; 6) bins for additions; 7) coke bins; 8) coke screen; 9) weighing equipment; 10) conveyors; 11) bins for coke fines.

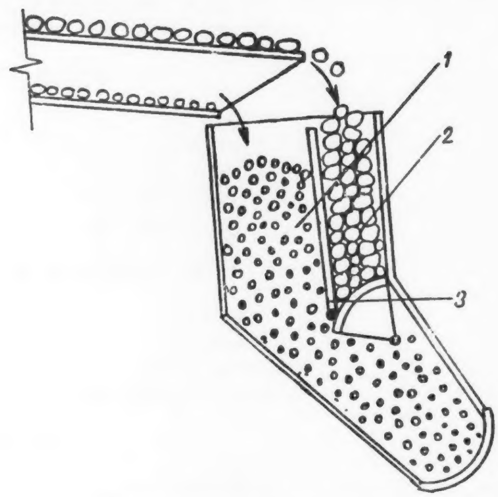

Fig. 3. Weighing hopper for coke; 1) compartment for 30-60 mm fraction; 2) compartment for +60 mm fraction; 3) partition.

The valves are interlinked with the bells. The steam inlets into the gas ducts are perpendicular to the gas flow in order to ensure a complete mixing of the gas and steam. By using this method of charging steam, an annual saving of 1700 rubles has been achieved.

Hearth Operations

A great deal has been done at the Magnitogorsk Metallurgical Combine to facilitate the work of furnace attendants. A modified design of the clay gun has made it possible to increase the pressure on the piston to 180 tons. An integral machine for dismantling the iron notch frame, and for boring and clearing the iron notch, has been introduced. The casting yard crane has been provided with grab buckets for sand delivery. The hot metal is tapped into the ladles by means of a movable runner (single-spout pouring).

Nevertheless, this section of the blast-furnace shop still has very hard working conditions. It is necessary to develop machines for clearing the runners, and the casting yard platforms, for lining the runners with refractory materials, for changing the cooling equipment, for ramming the iron notch frame, and for lancing the iron and cinder notches; it is also necessary to provide containers for sand, conveyor belt material, and small coke which could be unloaded rapidly without manual work. The material for ramming the runners should be more durable.

The crane in the cast yard should be changed to remote control. The changing of ladles during the casting of pig iron and slag should be made automatic. A penumatic system should be used for transporting samples to the laboratory.

Blast-Furnace Stoves

An automatic valve change system involving pulse emission from the time-relay or when the mixing valve is completely closed has been put into operation. Each of the blast-furnace stoves can operate on one of the three basic regimes: "on gas," "on blast," "on isolation," and on a special regime, "on draft."

Provision is made for three types of control: automatic, cyclic, and individual. During the "on draft" regime, the control of each valve is on an individual basis.

During the normal operation of the proposed scheme, the following parameters are measured: the pressure difference between the pressure in blast-furnace stoves and the atmospheric pressure, the pressure of the gas in the gas duct (minimum 50 mm of water), the temperature of the walls of the combustion chamber in the blast-furnace stove (minimum 700°C), the combustion of the gas in the combustion chamber (by means of a photorelay every 7 seconds), and the temperature in the dome of the blast-furnace stoves (maximum 1250°C). The temperature regulator of the blast-furnace-stove dome changes the measuring and command circuits to one of the blast-furnace stoves automatically every 3.6 seconds by emitting the pulse for changing the position of the gas valve in order to maintain the temperature in the blast-furnace-stove dome at a predetermined level.

The gas valve and the gas shut-off valves are closed if the air fan stops.

The sequence of valve changes and the regime of blast-furnace-stove operation is controlled by means of a light and sound signal system. An emergency signal system (light and sound) is switched in if there is a break in the electric power supply, if the gas valves are shut by accident, if there is a failure in the automatic control system, if there is no fuel firing at a time when the blast-furnace stoves are switched to "on gas", or if the flame goes out at a time when the blast-furnace stoves are heated.

The automatic valve changes of the blast-furnace stove reduced the time for valve changing by 3-4 minutes and made it possible to increase the temperature of the blast by 15°C.

The Automation of the Blast-Furnace Process

The introduction of an automatic control of the blast-furnace process is impossible without establishing a systematic reception of pulses essential for the control of the process.

A special apparatus which collects samples of the gas along diametrically opposite radii in the furnace at a level 100 mm below the guard ring of the blast-furnace top, and in the stock, has been developed with the object of obtaining data on the composition and temperature of the gas in the stock. The insertion of the sampling tubes is synchronized so that they are arrested in the corresponding positions in the vertical plane.

The Automation Laboratory of the Combine, the TsPKB and the Blast-Furnace Shop are carrying out investigations on the automation of two aspects of the remote control apparatus:

a) for taking gas samples and measuring the temperature at individual points along radii of the furnace;

b) for the continuous control of the temperature and the CO_2 content during the insertion of the sampling tubes.

Research work on the automatic control of the blast-furnace process based on partial pressure drops and on the condition of the tuyeres as well as on the distribution of the blast over the individual tuyeres, is under way.

MEASURING AND CONTROLLING THE WEIGHT OF THE COKE FEED

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"Azovstal'" Plant

Translated from Metallurg, No. 11, pp. 10-11, November, 1960

Usually the weight of the coke in the feed is varied on the order of the foreman by the duty electrician who sets the required weight by moving a mechanical setting mechanism on the head of the scales. Much time is spent in conveying and carrying out the order; furthermore, the foreman does not know whether the order has been accurately carried out since the value of the selected weight is not recorded.

At the request of blast-furnace technicians at the "Azovstal'" Plant after extensive searches and tests of various transmitting elements and instruments,a simple and reliable system of control and inspection for the operation of coke dial scales was developed and successfully tested (more than two years). The transmitting element of the system was designed for prolonged operation under the rigorous conditions under the hopper. The system consists of two contact contactless selsyns of the type BD-404A and BS-404A and an instrument based on the electronic automatic bridge type MSR-1 or the potentiometer type PSR-1.

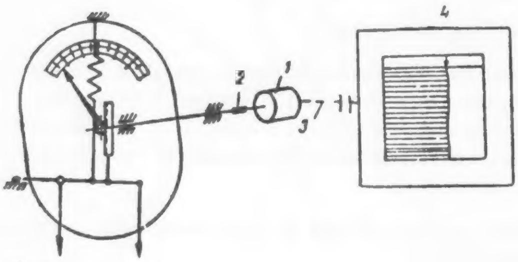

Fig. 1. Simplified kinematic arrangement for recording weight of coke: 1) transmitting selsyn; 2) linkage; 3) cable route; 4) recording instrument.

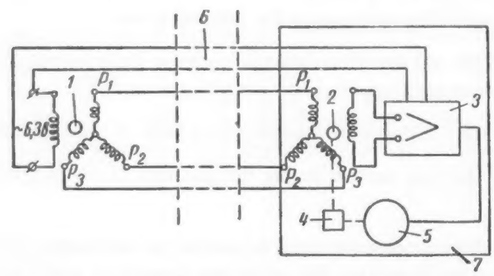

Fig. 2. Circuit of tracking system: 1) transmitting selsyn; 2) receiving selsyn; 3) electronic amplifier; 4) reducer; 5) reversing motor; 6) cables; 7) movement recorder.

A simplified kinematic diagram of the recording of the coke weight is shown in Fig. 1. The transmitting selsyn is mounted on the back wall of the scale on the head of the balance. Its shaft is joined mechanically to the shaft of the scale pointer. The transmitter is electrically connected with the control instrument by a 7-core cable (fives cores to transmit the readings and two to control the weight).

The controlling instruments, connected with the right and left coke dial scale heads, are mounted on the main panel of the control and measuring instruments and automatics. The transmitter and instrument are a tracking system in which the selsyns operate in a transformer arrangement (Fig. 2).

The transmitting selsyn is fed by a voltage reduced twenty times in relation to the nominal value, which makes it possible to reduce the torque on its shaft almost to zero without affecting the accuracy of operation of the scales. The receiving selsyn is mounted in the recording instrument, its stator winding is connected to the input of the electronic amplifier, which amplifies the mismatch signal and controls the rotation of the reversing motor, with whose shaft of the receiving selsyn is connected through a reducer, the recording pointer, and the control device.

The automatic control and remote order for a setting for the required weight is provided by a two-position control device of a self-recording instrument. The main circuit of the remote control for the weight of the coke feed is given in Fig. 3.

On the dial pointer of the scale there is a mercury contact which is closed by the pointer when the weight of the coke in the hopper approaches the given value and stops the roller screen. As the contact moves along the periphery of the dial,the given weight of coke is controlled.

The feed can be varied by a remote control device of the instrument if its contacts are connected in parallel with the mercury contact. It is then moved by the maximum weight of coke which can be held by the skip and operate as a blocking contact in the case of shut-down or nonoperation of the control part of the instrument.

The contact on the disc of the setting mechanism connects the intermediate relay MKU-48, the N.O. contacts of which are connected through a switch VK-2 in parallel with the mercury contact. The command is set by the foreman who moves the pointer of the setting mechanism along the scale of the instrument and changes the distance between the recess on the textolite disc and the moving contact. When the measuring pointer is moved the textolite disc is moved simultaneously, and when it approaches the pointer of the setting mechanism

with a certain amount of advancing the contact is closed on the disc of the setting mechanism, which closes the circuit feeding the winding of the MKU-48 relay. The contacts of this relay switch off the drive of the screen.

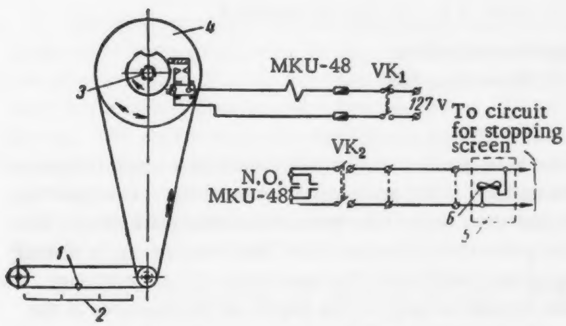

Fig. 3. Main circuit for controlling weight of coke feed from the central panel of the control and measuring instruments and automatics of the blast furnace: 1) setting mechanism; 2) scale; 3) shaft of reversing motor; 4) disc of setting mechanism with contacts; 5) instruments on dial of scale; 6) mercury contact.

The accuracy in weighing the coke is fixed by the Gipromez specifications within ± 20 kg of the given weight. Prolonged operation of four instruments at two blast-furnaces of the "Azovstal'" Plant has shown that these instruments are sufficiently accurate in recording and controlling the weight of the coke feed.

Simultaneous observations on the right and left heads of the scales (on the left the weight of the feed was controlled by a mercury contact, and on the right by means of a two-position regulator) showed (see table) that the deviation of the weight of coke from the given value when controlling with a two-position device is a half of that without the device.

This year it is planned to equip the remaining blast-furnaces of the plant with these instruments. A specialized design organization should generalize the experience of the "Azovstal'" Plant and arrange for batch production of instruments for controlling the weight of coke.

Results of Tests on the Control Arrangement

Given weight	Actually taken weight	
	left head	right head
2100	2100	2100
2100	2088	2098
2100	2090	2099
2100	2090	2100
2100	2090	2100
2100	2100	2099
2100	2090	2100
2100	2110	2102
2100	2092	2097
2100	2095	2100
2100	2090	2098
2100	2096	2100

A DEVICE FOR MEASURING THE TEMPERATURE AT THE WALLS OF THE STACK

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Urals Polytechnical Institute and Nizhni Tagil Steel Combine
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High productivity and economic operation of the blast-furnace can be achieved with a certain degree of development of the peripheral stream of gases and its uniform distribution along the periphery. It is therefore very important to detect temperature deviations, in good time and to take measures to eliminate them. The thermocouples used for these purposes, mounted in the protective segments of the blast-furnace top or directly under them,are placed in the zone of intense heating of the materials in the upper stage of heat exchange. The absolute values of temperatures under these conditions depend not only on the degree of development of the peripheral stream, but also on the rhythm of charging, the temperature of the charged materials, the incompleteness of the furnace, etc.

As shown by investigations carried out at the Nizhni Tagil and Magnitogorsk Combines, the heat-exchange processes are almost completed in the peripheral zone at 7-9 m below the stock line. It would therefore be better to mount temperature transmitters here; this would make it possible to use the temperature deviations to evaluate the uniformity of distribution of the gas stream and to use the average temperature around the periphery for the automatic control of the thermal state of the furnace.

At the Nizhni Tagil Steel Combine,new temperature transmitters have been tested which are sufficiently accurate, sensitive, and durable.

Depending on the specific consumption of coke and the content of ore in the charge,the temperature at the stack walls at a depth of 7-9 m can vary from 750 to 1100°. In this range the temperature can be measured by thermocouples or radiation and photoelectric pyrometers which, however, are very inaccurate when measuring temperatures below 900°

Special complex devices are needed when using radiation pyrometers to measure the temperatures in the blast-furnace stacks. Thermoelectric pyrometers are somewhat simpler. The temperature in the stack must be measured in a medium of blast-furnace gas where there are small amounts of SO_2, and sometimes zinc and alkalis, as well as the high content of CO and CO_2.

At temperatures of 500-600°, carbon monoxide is decomposed with the liberation of carbon, which can carburize the thermal electrodes and spoil their characteristics. Furthermore, the deposition of carbon black in the protective covers of the thermocouples can complicate their operation. Small amounts of SO_2 cause very rapid corrosion of some alloys, leading to failure. The reaction of iron zinc develops at temperatures above 480°. At higher temperatures the alloy fails due to the formation of compounds such as $FeZn_3$ and $FeZn_7$.

When measuring the temperatures at the stack walls with a low-inertia thermocouple it is essential that the working junction be taken beyond the limits of the brickwork into the working space of the furnace. The working junction of the thermocouple must be protected from the aggressive action of the gas stream and the rubbing action of the charge. The material of the protective cover must therefore be able to withstand this action and not reduce the sensitivity of the thermocouple.

The working conditions in the peripheral zone of a blast-furnace therefore indicate the following main operating requirements for thermocouples and their protection:

1) prolonged measurement of temperatures in the range 600-1300°;

2) sufficient durability of the protective equipment in this range of temperatures;

3) minimum delay during measurement;

4) satisfactory durability of the thermocouples and their protective equipment to the action of gases.

At the present time, instruments for measuring temperatures in the region of protective segments are placed in massive protective tubes, the ends of which are closed with a metal stopper of 75-100 mm thickness on the side near the inside of the furnace. The end of the tube is taken out facing the internal surface of the brickwork or adjoins the internal surface of the segments.

The proposed device for measuring temperatures at the stack walls of a blast-furnace (Fig. 1) consists of a water-cooled tube of diameter 57 mm. At the end of the tube there is a tip of heat-resistant steel or heat-resistant alloy of length 250-260 mm with 18 mm wall thickness. In the inner channel of the tube of diameter 20 mm there is a standard chromel-alumel thermocouple, the working junction of which adjoins the inside end surface of the tip. The device is put into the furnace through a hole in the brickwork so that the tip is in the working space of the furnace at a distance of 80-100 mm from the brickwork. To create a protective atmosphere around the working junction of the thermocouple air is fed to the inside channel from the cold blast pipe. The stuffing box seal and the sliding gate make it possible to replace the whole device and thermocouples during operation of the furnace.

The following factors were borne in mind when designing the device.

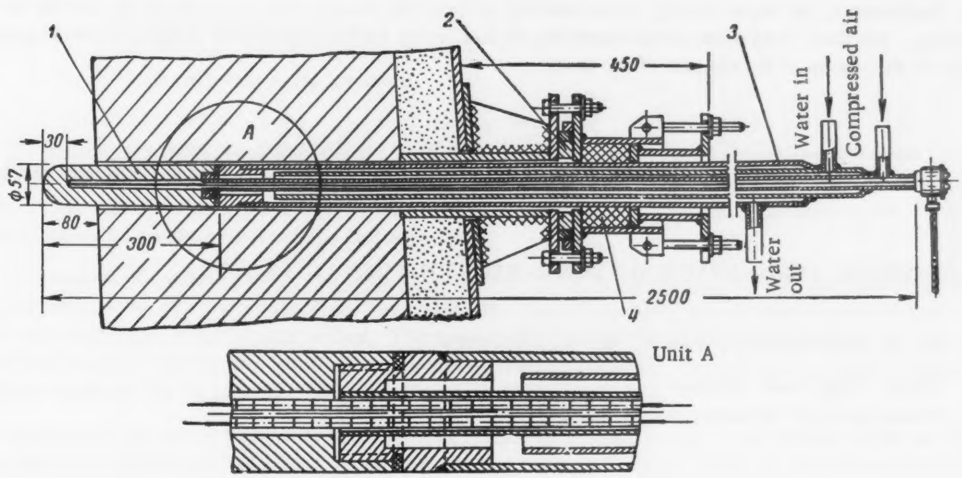

Fig. 1. Device for measuring the temperature at the stack walls of a blast-furnace: 1) tip; 2) sliding gate; 3) water-cooled tube; 4) stuffing box.

A chromel-alumel thermocouple can measure temperatures up to 1300°. Feeding air to the inside channel of the tube at a pressure higher than that of the gas in the furnace provides an oxidizing atmosphere and prevents the penetration of aggressive gases, and also vapors of zinc and alkali, thus providing the best operating conditions for the thermocouples. Bringing the tip and working junction of the thermocouple into the furnace considerably reduces the delay in readings and increases the sensitivity of the thermocouple to temperature changes in the furnace. As they move, the pieces of charge "grind" the tip and thereby prevent the formation of hardened slag on its surface. The water-cooled casing provides sufficient mechanical strength for the whole device.

The most important component of this device is the tip. Its durability depends on the composition and properties of the material from which it is made. The most suitable for these purposes are chrome-nickel steels and nichrome-type alloys.

The device for measuring temperatures in the stack was tested on one of the blast-furnaces of the Nizhni Tagil Steel Combine. The thermocouples were placed in the middle of the stack at a height of 12.8 m from the level of the tuyeres (I level) and 4 m above the level of the tuyeres (II level). Tips were tested on steels ÉI72, 1Kh18N9T, ÉI257, and Kh80N20 alloy.

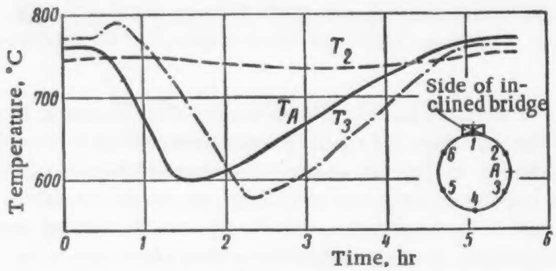

Fig. 2. A comparison of the readings of the tested thermocouples and the industrial type: 1-6) points of installation of the industrial thermocouples; A) point of installation of the tested thermocouple; T_2, T_3, and T_A are the readings of the thermocouples at the points 2, 3, and A.

A comparison of the sensitivity of these devices for measuring temperatures at the stack walls and standard industrial devices measuring the temperature at the periphery shows that the sensitivity of the tested thermocouple is higher than the industrial type and the delay time is less (Fig. 2). An analysis of the changes in temperature shows that the minimum value of the thermocouple temperature was observed 45 min earlier than with the industrial type.

The higher sensitivity of thermocouples with protective tips is due to the fact that the relatively light tip needs much less time for heating than the internal surfaces of the stack walls where the protective tube with thermocouple is placed for measuring the temperature of the peripheral gases. Furthermore, the tip is directly in the working space of the furnace and is surrounded by the stream of gas and charge. All these facts point to the suitability of this device for tunning control of the peripheral gas temperature in the region of the top part of the stack.

The Steelmaking Industry

THE THERMAL INSULATION OF OPEN-HEARTH FURNACE ROOFS

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Nizhni Tagil Steel Combine

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Tests were started in February, 1957 on the thermal insulation of the basic roofs and other elements of the refractory lining of open-hearth furnaces at the Nizhni Tagil Steel Combine. Favorable results from these tests led to the extensive introduction of thermal insulation of roofs at all medium tonnage furnaces of one open-hearth department, and by November, 1957, all furnaces were thermally insulated.* During 1958, tests were made on the insulation of roofs and other elements of the lining at two large-tonnage furnaces (in three compaigns), operating with oxygen.

During the three year operation with thermal insulation 39 campaigns were run, 7 of them with the insulation applied in the middle or at the end of the campaign and 32 at the start of the campaign.

The operation of the department has shown a systematic increase in productivity and durability of the furnaces and a reduction in the specific consumption of fuel (Table 1).

The improvement in the indices is due to the introduction of a number of important organizational and technical measures and increase in the general standard of production in the department. The following factors have had a particularly important effect on the results of operation: improving the delivery of compressed air to the department, reducing the number and periods of cold and hot repairs (including hearth repairs), strengthening the design of the roof fastening, and improving the furnace maintenance during the campaign. The fuel con-

* Apart from the authors, those taking part in the work were F. V. Gusarov, V. G. Udovenko, G. A. Petrov, V. E. Burkser, I. A. Shmonin, E. A. Kudrin, S. N. Galakhmatov, L. P. Zimina, B. N. Shisharin, R. V. Kondyurina, K. A. Burmistrov, I. A. Shirnin, F. N. Simenenko, Yu. V. Gorshilov, B. V. Kolpakov, A. K. Gusarov, P. G. Bolotov, and others.

sumption indices in particular have been considerably improved by the thermal insulation of the refractory lining of the open-hearth furnaces, especially the roofs of the working space and the heads.

TABLE 1

Basic Indices of Operation for Medium Tonnage Open-Hearth Furnaces

Indices	1956*	1957**	1958***	1959***
Steel removal, ton/m^2 · · day	7.45	7.83	8.22	8.57
Specific consumption of ideal fuel, kg/ton	191.0	180.0	170.0	170.0
Including smelting	172.7	166.8	157.1	157.8
Durability of furnaces (with regard to roof), heats	484	545	556	599

* Without thermal insulation.
** 47.8% heats with thermal insulation.
*** All roofs thermally insulated.

All open-hearth furnaces of the Nizhni Tagil Steel Combine operate with the scrap-ore process on molten iron (about 65% of the weight of metal charge). The furnaces are fixed with a mixture of coke oven and blast-furnace gases, carburated during the melting and final melting periods by coal tar or anthracene oil. The combustion is intensified with compressed air and oxygen.

The roofs of the working space and head of medium-tonnage furnaces are lined with chrome-magnesite brick and those of the 380-ton furnaces are lined with periclase-spinel from the Satkinsk Refractory Plant. The spaced suspension type of roof design is used. The main roofs are smooth and made up of 460-mm brick and the roofs of the heads are of 380-mm brick using reinforced plates of 0.75-1.25 mm thickness, suspended plates of 1.5-2 mm thickness and 16 mm diameter pins of St. 2 and St. 3 steel.

Each arc of the roof is wedged by three locking bricks. One lock is made in the middle of the arc and two at the sides, at a distance of 1/4 of the length from the support beams. The locking bricks are hammered in for a distance of 100-150 mm. The suspended plates and corners are placed along the roof every 6-9 bricks in 13 lines. The roof is suspended until the molds are removed. The new roof is heated according to the standard instructions. After heating, the seams of the roof are filled with a mixture of magnesite powder and scale (1:1).

The roofs of the working space and the heads are thermally insulated without stopping the furnaces. The insulating material is a lightweight fireclay brick of volumetric weight 1.3 g/cm^3. The fireclay bricks are applied dry to a die of 65 mm, between the suspended corners. During the campaign, the roof, especially the suspended corners, is blown with compressed air every day to remove dust.

After heating the thermally insulated roof,the spaced suspension system is again adjusted so that there is no free play in the fastening.

The walls of the heads and the vertical channels on all furnaces are lined with chrome-magnesite brick, efficiently sealed and thermally insulated with a light-weight fireclay brick, placed on a semithick paste of fireclay mortar with the addition of a small amount of water glass. The thickness of the insulation is 65 mm.

The plans include thermal insulation of the bottom structure of the furnaces and this is made from lightweight fireclay (thickness 125 mm on a semithick plate). The air checkerworks of the 380-ton furnaces are blown with compressed air (every week) or are washed with high-pressure water (once a month). At other furnaces, these operations are performed occasionally.

At the combine a system of preventive hot repairs has been introduced (during the campaign) in which the lining of separate elements of the furnace is partly renewed (bulkheads of the front wall, lining of the caissons, partial replacement of the checkerworks, etc.) and slag is also removed from the slag pockets. The roofs of the working space are not repaired, and as a rule on the 380-ton furnaces they are not cooled below 1100°. At the other furnaces the hot repairs are carried out with the fuel disconnected.

Every week all furnaces are inspected by a special commission consisting of representatives of the open-hearth departments, TsRMP*, and the thermotechnical laboratory of the combine.

Open-hearth furnaces which are thermally insulated have a higher productivity and are more economic than those without insulation. Even with reduced thermal loads the productivity of the furnaces which are thermally insulated in the middle or at the end of the campaign was increased by 4.4-6.9% and the specific consumption of fuel was reduced by 12.5-15.7 kg/ton of useful ingots. The productivity of furnaces thermally insulated at the start of the campaign was increased by 1.3-4.6% and the specific consumption of fuel was reduced by 3.6-9.7% (Table 2).

TABLE 2

Results of Open-Hearth Furnace Operation

Indices	Furnaces			
	medium tonnage		large tonnage	
	without insulation	with thermal insulation	without insulation	with thermal insulation
Duration of heat, hr	8.50-10.44	8.27-10.11	10.16	10.06
Mean thermal load, millions kcal/hr	20.30-23.41	19.67-22.47	26.40	25.65
Smelting specific consumption of ideal fuel, kg/ton	174.9-135.3	164.9-122.2	100.6	96.8

During a campaign, furnaces with thermal insulation usually operate much more evenly from the thermal standpoint than those without insulation (see figure). The improved operation is due to the considerable reduction in heat losses through the lining. For example, the heat losses through the roof of the working space were reduced 3-3.5 fold by insulation. The reduction in heat losses gives hotter furnace operation during the campaign, which in its turn has a favorable effect on the operating rhythm of the department as a whole.

The improvement in the indices is also due to the increased temperature of the working surface of the roof, especially during charging and heating of the charge materials (by 10-65°) and also the high heat-accumulating capacity of the insulated lining (by about 1.25 times).

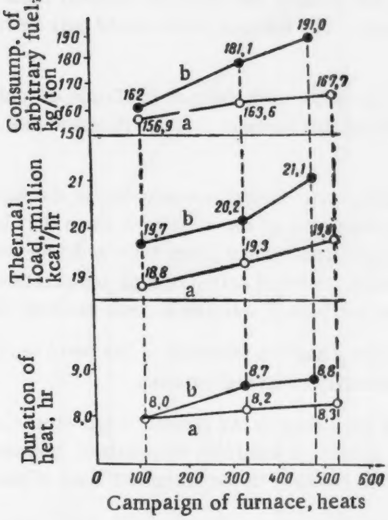
With thermal insulation there were changes in the operating conditions and the character of wear of the refractory components. The insulation gives a more stable temperature system in the roof, especially during the periods of comparatively low temperatures (the addition of the charge and additional materials, reversing of the valves, blowing out the "stagnant" slag during hearth repairs, etc.). This has a favorable effect on the operation of the refractories. This feature is best seen toward the end of the campaign.

In order to provide normal temperature operation of the surface of the thermally insulated roofs during the periods of melting and final melting (1710-1720°), the thermal loads were reduced by 5-7%.

The temperature of the external surface of the roof lining (under the insulation layer) is increased on the average over the whole area to 650-1050° (without insulation it is 350-650°; the higher figures refer to the end of the campaign).

* Shop for repair of open-hearth furnaces.

On the one hand, this factor spoils the operating conditions of the roofs since with thermal insulation the plates and pins are somewhat more rapidly oxidized and burnt. On the other hand, the increase in temperature of the refractory mass and the corresponding reduction in the temperature drop along the height of the brick has a favorable effect: the joints in the roof lining are less uncovered, and the contact of the bricks in the rings is preserved over a large area. This reduces the unfavorable effect of the stresses which are introduced in the roof.



Operating indices of low-tonnage furnaces as a function of the age of the furnace: a) with thermal insulation; b) without thermal insulation.

Furthermore, the higher temperature of the roof (when it is made sufficiently tightly) usually considerably improves the fusability of the bricks, especially in the rings. This provides fairly good stability of the roof, even when the roof is fairly thin and the suspensions have already oxidized and hardly work.

The more uniform temperature system of the roof lining and the higher degree of fusability of the thermally insulated roofs make it possible to produce more heats during the campaign and to operate to a much lower residual thickness of the roof than was the case without thermal insulation, providing the furnaces are well maintained and the roofs are carefully unfastened.

In single-spout furnaces operating with compressed air, the maximum durability of the thermally insulated roofs reached 646-740 heats at a number of furnaces during the introduction of insulation. This is much higher than the maximum durability of roofs without thermal insulation (606 heats). The average durability during three years operation of thermally insulated roofs was 618 heats (without thermal insulation this figure was 520 heats).

Those operating under the most severe conditions were the roofs in 260-ton two-spout furnaces which usually operate with oxygen and have a very deep bath. The durability of roofs in these furnaces with thermal insulation was reduced, although slightly, and averaged 460 heats (without thermal insulation it was 470 heats).

As regards fusability there is a little difference between insulated roofs and noninsulated-periclase-spinel roofs. The Satkinsk periclase-spinel brick is characterized by local fusability (mainly around the pins). In this respect also they are inferior to chrome-magnesite bricks.

The durability of 380-ton-furnace roofs operating with oxygen averaged 486 heats with thermal insulation and 470 heats without insulation.

The rate of wear of thermally insulated roofs hardly increased at all. As a rule, the insulated roofs wear more evenly along the width and length of the roof. Their wear occurs mainly due to chipping of the thinner sections of the working zone of the brick. At the same time, there was no plastic deformation of the brick nor noticeable traces of sweating of the working surface of the roofs with thermal insulation.

Soon after the application of insulation the height of the roof increases by 25-30 mm. This must be allowed for when suspending and unfastening it to avoid disturbing the continuity of the spaced suspension system and the whole roof. The construction of the spacing system should be more rigid and stronger than usual.

The importance of good and uniformly reliable unfastening of the roof at all of its sections (especially at the end of the campaign) is also borne out by the fact that by this time the pins and plates have become strongly oxidized. This of course is also true of noninsulated roofs. Interference with the spacing devices can lead to buckling of the roof along the back or front walls and to sagging in the central part. The weight of the roof is then so great that even with good fusability of the lining, cracks appear in it.

The roof must not be cooled rapidly (especially at the end of the campaign) due to removal of the thermal insulation, the application of cooling water, or the momentary reduction in temperature of the working surface of the roof to 1450° and less, especially when the roof is already bent.

Thermal insulation of the main lining of the heads and vertical channels above the level of the working area does not cause any complications in the operation of the furnaces.

Experience shows that as a result of thermal insulation, furnaces with basic roofs compare to furnaces having Dinas roofs as regards the level of thermal loads, and as regards specific consumption of fuel they are even more economical. This shows that we should reexamine the graphs of thermal systems and bring the thermal loads into correspondence with the changed conditions of operation of the furnaces. The thermal loads should only be reduced during the periods of melting and final melting.

Three years experience of operation at the Nizhni Tagil Steel Combine with thermal insulation of roofs and other elements of the lining, has shown that the economic effectiveness of this measure is 102.0 thousand rubles per year for one furnace.

At the same time it has been shown that under conditions of sufficiently careful maintenance of the furnaces and checks on their condition, thermal insulation does not reduce the durability of the roofs even when they have a simplified design (smooth). Obviously, when the roofs are made longitudinal ribbed (from 460- and 540-mm brick laid in the ratio 6-7 : 2) with the suspension system taken out of the sphere of action of high temperatures, the roof durability is still higher. This will facilitate the use of plates and pins of stainless or heat-resistant steels.

The roof durability is also improved by removing faults in the lining and the fastening of the basic roofs, in the methods for insulating them and methods for operating with thermally insulated furnaces.

On the basis of the favorable results obtained in tests of thermal insulation in the Nizhni Tagil Steel Combine open-hearth furnaces, this method can be recommended to other plants. It should be emphasized, however, that the introduction of thermal insulation should be accompanied by an increase in the technical level of production.

EQUIPMENT FOR THE SEMIAUTOMATIC LUBRICATION OF MOLDS

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In 1957, equipment was installed at the Nizhni Tagil Combine to lubricate molds; it works reliably and gives good quality lubrication of the molds. The laborious and dangerous operation of preparing the molds for pouring has been automated.

The machine for the lubrication (Fig. 1) is mounted on the trolley of a bridge crane and has mechanisms for moving the lower and upper trolleys and sprays. All mechanisms of the equipment are remote controlled from a special station placed on the balcony in the lubrication building.

The mechanism for moving the upper trolley is placed on the frame of the lower trolley and consists of an executive mechanism type IM-2/2.5, track switch, and rack, one end of which is firmly fixed to the frame of the other trolley and the other slides freely along two rollers.

To lubricate the molds, the upper trolley has a descending spray spraying varnish on the inside walls of the molds. The spray is automatically moved up and down between rollers by means of an electrical executive mechanism type IM-2/2.5, the shaft of which is connected with that of the block for moving the spray. The varnish for lubricating the molds is brought to the spray in a rubber-jacketed hose.

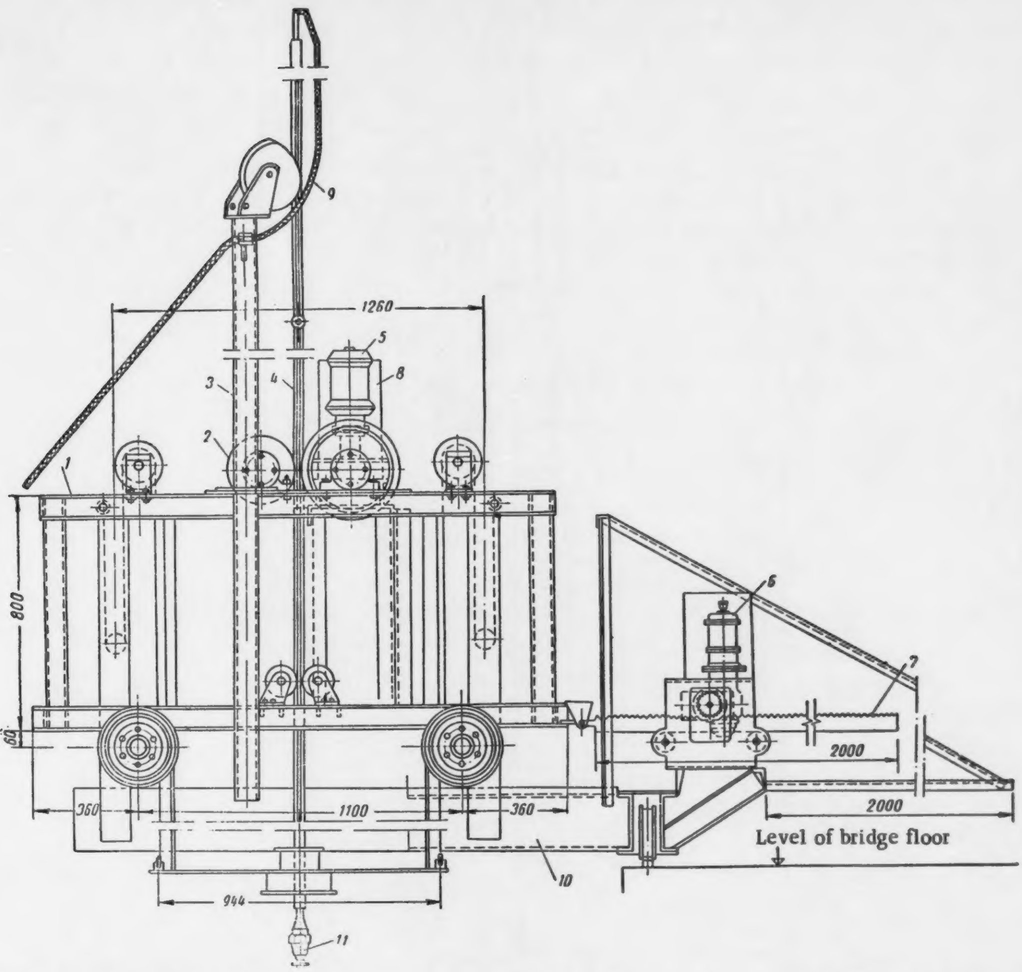


Fig. 1. Machine for lubricating molds: 1) upper trolley; 2) block for moving sprays; 3) pillar for mounting slide roller; 4) metal tube; 5) executive mechanism for moving spray; 6) executive mechanism for transverse movement of the upper trolley; 7) rack; 8) track switch; 9) hose for delivering varnish; 10) bottom trolley; 11) spray.

In the spray for lubricating the molds (Fig. 2) the varnish is atomized by compressed air. It is forced to the spray by the pressure of the compressed air fed to the tank containing the lubricant. Constant flow of varnish at the spray is maintained automatically by the constant pressure of the compressed air in the tank. The temperature of the varnish is automatically controlled by changing the supply of steam to a coil in the tank. The cross sections of the holes in the spray are calibrated with a special device which measures the amount of water passing through the spray in a given interval of time.

In case the hose tears off or the sprays are damaged, the varnish supply can be stopped by a solenoid-type cutoff valve in the main supply line. Because of the different heights of the molds, on the control panel there is a universal UP-1 switch with three positions, depending on the types of molds. The universal UP-2 switch can select the control for the spray.

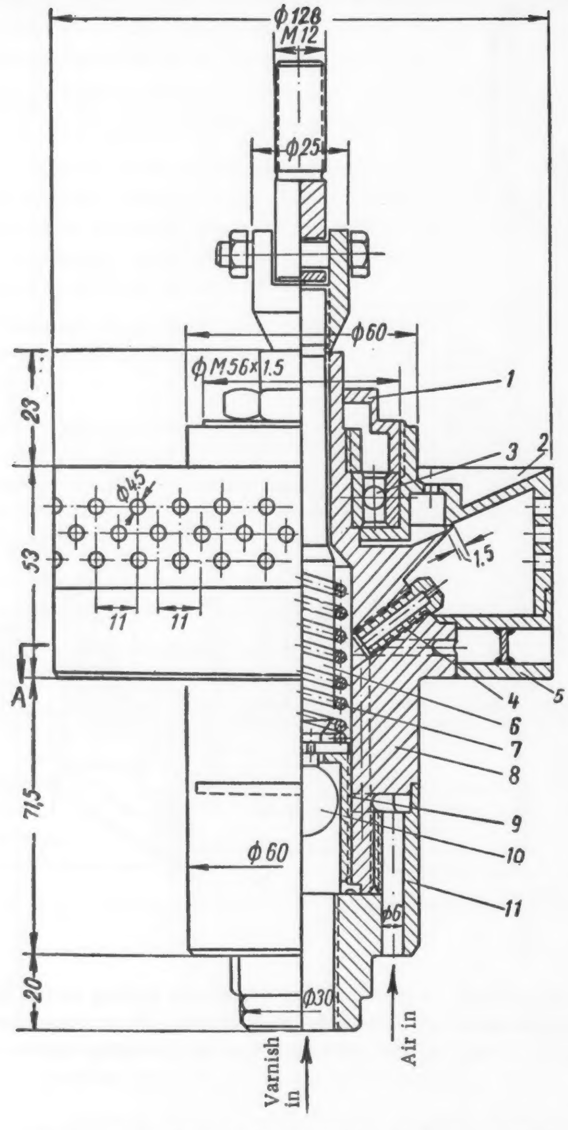


Fig. 2. Spray for lubricating molds: 1) thrust nut; 2) disc-atomizer; 3) ball bearing; 4) nozzle; 5) turbine; 6) valve push rod; 7) spring; 8) spray housing; 9) valve saddle; 10) ball; 11) varnish and air receiver.

In the control room there is a temperature switchboard with self-recording and indicating instruments measuring the pressure of the compressed air, the temperature of the varnish in the tank, and the temperature of the surface of the molds. To measure the temperature of the mold surface before lubrication the rod of the pneumatic piston forward movement servomotor has a special copper-constantan surface thermocouple. The servomotor (thermocouple) is remote controlled from the lubrication control panel. Furthermore, at the control panel there is a push-button station for switching on the ventilator to remove gases liberated during the lubrication of hot molds.

[Continued on p. 502.]

THE AUTOMATION OF METALLURGICAL PLANTS—AN URGENT TASK OF OUR TIME

Diagrams for the article by K. P. Kostenetskii pages 476-482

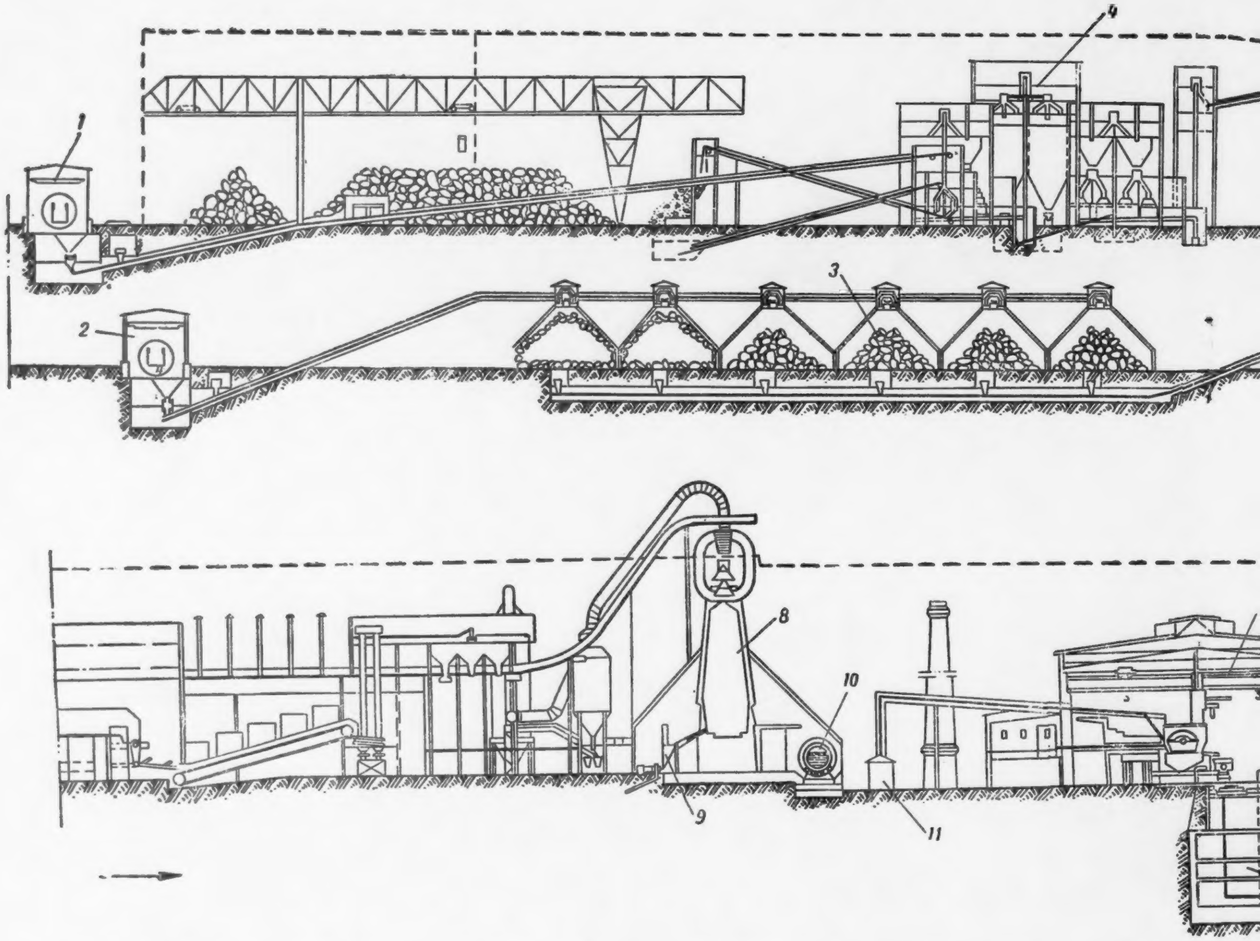


Fig. 1. Diagram of automated metallurgical plant. 1) Car dumper for coal; 2) car dumper for ore; 3) ore storage with stanc
7) agglomerate plant; 8) blast-furnace works; 9) hydraulic equipment for slag; 10) mixer; 11) pump station of induction pum
15) rolling mill works.

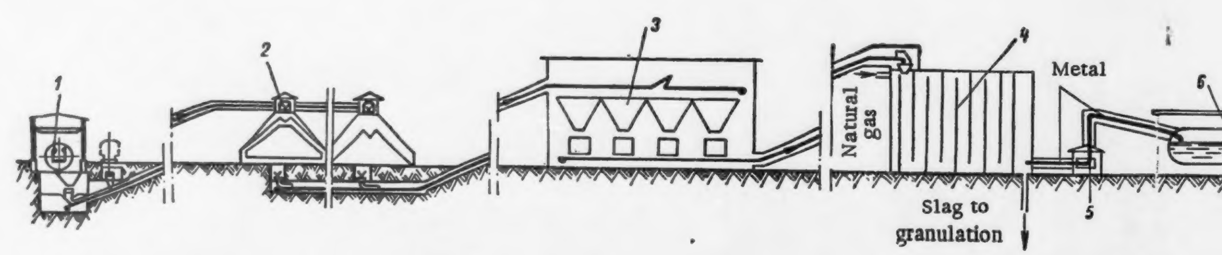
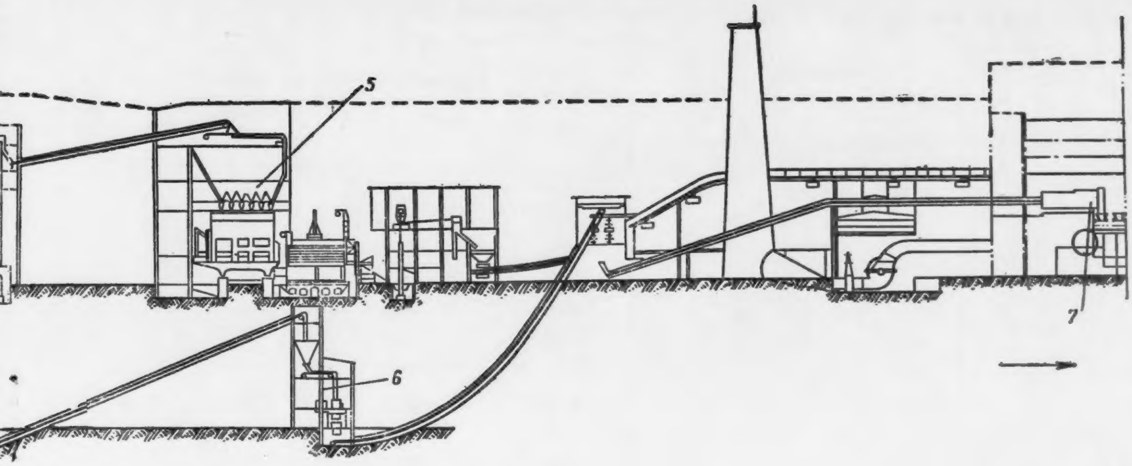
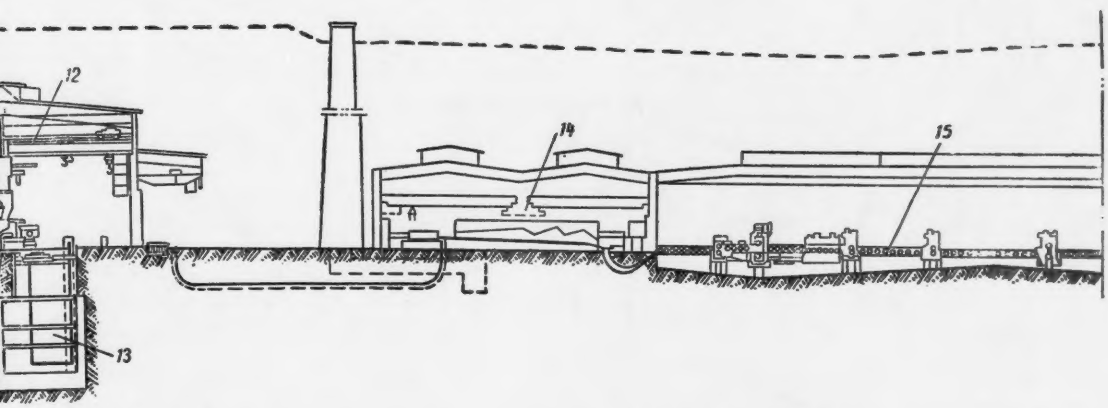
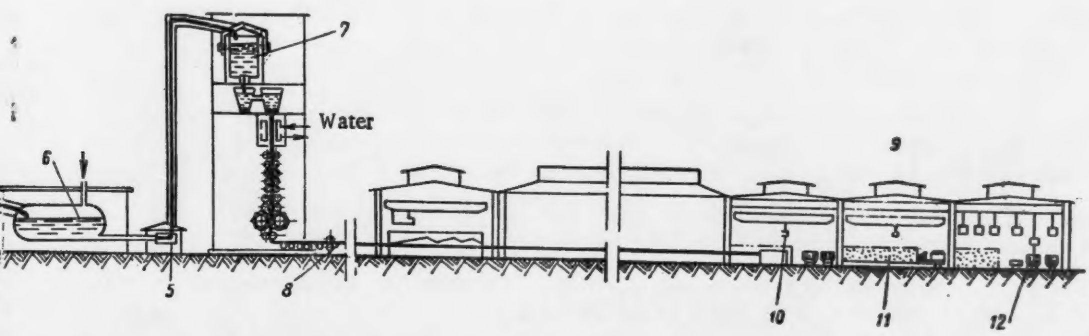


Fig. 2. Diagram of factory based on new processes. 1) Car dumper; 2) charge storage; 3) separation and preparation of uni
metal; 7) active mixter; 8) endless rolling; 9) rolled-iron storage; 10) loading by cranes; 11) loading by automatic load ers;





n standardizing machinery; 4) coal preparation; 5) coal-tar chemical plant; 6) crushing-sorting separation of ore;
n pumps; 12) open-hearth furnace works; 13) continuous steel pouring machine; 14) straight through method furnace;



of uniform charge; 4) direct reduction process chambers; 5) pump of induction pumps; 6) equipment for alloying of
ad ers; 12) loading by special monorail bogies.

Durability of Different Types of Molds with Automatic and Manual Lubrication

Type of mold	Weight, ton		Years	Mean life, heats	Specific consumption of molds, kg/ton of steel
	ingot	mold			
		With automatic lubrication			
O-24* (tube)	7.23	6.13	1956	41.9	21.2
			1957	45.4	19.5
			1958	48.4	18.4
			1959	46.6	18.5
OK-6* (rimming)	7.0	7.64	1956	89.0	12.5
			1957	94.1	12.1
			1958	93.2	11.6
			1959	89.4	12.3
O-21* (rail)	6.54	7.56	1956	46.6	23.3
			1957	49.3	22.3
			1958	55.3	19.9
			1959	53.6	21.6
		With manual lubrication			
L-6 (sheet)	5.95	6.26	1956	42.5	25.1
			1957	30.5	34.9
			1958	42.1	25.0
			1959	41.6	25.3
L-65 (sheet)	6.5	6.47	1956	30.0	33.9
			1957	24.5	41.5
			1958	31.6	32.2
			1959	28.2	35.3

* Up to July, 1957, manual lubrication was used on these types of molds.

The mold units are brought to the mold yard by a locomotive on ladle trolleys placed in pairs. In the lubrication building the mold units are moved in a longitudinal direction by a rack pusher from an electric motor controlled by the operator from a panel.

The transverse movement of the pusher, i.e., its engagement with the projections of the trolley and disengagement, is provided by a pneumatic piston servomotor which is also controlled from the control panel. Using the top and bottom trolleys four molds can be lubricated without moving the unit.

As a result of automation of mold lubrication there has been a 25% reduction in the number of workers engaged in the preparation of mold units for pouring. The labor productivity has been more than doubled.

The automation of mold lubrication has had a favorable effect on increasing their durability (see table). There has been a considerable improvement in the quality of the ingot surface.

BURNING-IN OF NEW BOTTOMS IN HEAVY-DUTY OPEN-HEARTH FURNACES

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Magnitogorsk Metallurgical Combine
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In recent years, in accordance with practice at other plants, the method of repairing furnace bottoms in thick layers using large quantities of mill scale has been put into practice on a permanent basis at the Magnitogorsk Metallurgical Combine. For speeding up the work of furnace bottom repair, pools of metal and slag are blown out by means of three pipes (using compressed air at high pressure), and magnesite powder is spread by means of a throwing machine. All this has made it possible to cut the stoppage time for bottom repair at the plant almost by half, from 2.16 to 1.13%, in four years.

Of the steps enumerated resulting in the reduction of stoppage time for bottom repair, burning-in by thick layers occupies a special position. It will be known that the thickness of the layers used in burning-in the bottom formerly did not exceed 20-25 mm. Currently, the thickness of the layers has been increased to 100 mm.

Many investigations have been made on methods of carrying out the burning-in of bottoms. The method of bottom repair and burning-in thick layers, currently employed at various plants, has not yet been put on a scientific basis. This is due to the fact that each plant or shop seeks to ascertain by hit or miss methods, as it were, the possibility of speeding up the burning-in of bottoms still further by increasing the thickness of the layers to 50-60 mm and then to 100 mm.

On the basis of experience gained in the burning-in of bottoms by thick layers, four new bottoms in heavy-duty open-hearth furnaces were burnt-in by the accelerated method at the Magnitogorsk Combine in 1959. The following is a description of the burning-in process as applied to two heavy duty furnaces.* The particulars of these furnaces are as follows:

Area of hearth, m^2	105
Length of bath, m	17.8
Width of bath, m	5.9
Depth of bath, m	1.2

The port ends are single-channel, the slag-pocket roofs are magnesite-chromite, suspended and flat, and the regenerator roofs are high-alumina, suspended and flat.

The furnaces are fired by cold coke-oven gas and oil (30% by heat). The oil is atomized by air at a pressure of 3-4 atm.

The following are the particulars of the bottom structure:

Total thickness, mm	930
comprising:	
magnesite brick	775
rammed magnesite	40
firebrick	115
Thickness of bottom at tap-hole, mm	585
Thickness of back wall (base), mm	2050
Thickness of front wall (base), mm	2050
Thickness of banks (base), mm	1500
Slope of bottom to tap-hole	6°
Slope of banks	34°
Slope of back wall to level of dams	45°
Slope of front wall	43°

*The bottoms were burnt-in by head foreman M. G. Nechkin.

Before the bottom was burnt-in, the furnace was thoroughly heated and the temperature conditions were kept constant during the burning-in operation.

The heat load on furnace B was 3 million kcal/hour higher than on furnace A; this had a detrimental effect on the chemical composition of the bottom and its life. Excessively high heat load in burning-in a bottom is undesirable.

The materials used for burning-in the bottoms were Magnesite powder, "Extra" grade, without additional screening, burnt dolomite, dry mill scale, open-hearth rimming steel slag. The chemical composition of the materials was as follows, %:

	SiO_2	FeO	Fe_2O_3	Al_2O_3	MnO	CaO	MgO	P_2O_5	Cr_2O_3	S	Loss on ignition
Magnesite powder	2.0	–	1.0	0.40	0.10	2.20	94.9	–	–	0.007	0.30
Open-hearth slag	9.6	16.9	7.9	6.55	7.2	35.6	14.0	0.70	0.30	0.22	–
Mill scale	0.35	42.4	55.02	0.50	0.60	0.75	0.60	0.075	–	0.020	–

Composition of the burnt dolomite: 30.9% MgO; 63.2% CaO; 2.26% R_2O_3; 2.39% insoluble residue; 0.89% loss on ignition.

The mill scale was first screened through a sieve for removing foreign impurities, and the open-hearth slag was gound to a grain size of not larger than 3 mm.

The bottom of furnace A was burnt in five layers and that of furnace B in six layers. The first and last (thick) layers were burnt-in with pure magnesite powder. For the intermediate layers of the bottom and all the layers of the walls and banks, a mixture of magnesite powder, open-hearth slag, and mill scale was used. For the walls and banks a "richer" mix was made up, since in burning-in, their fusible constituents rapidly penetrate as far as the brickwork and the magnesite powder does not sinter so well.

The mix was made up strictly by weight. In one stage, the mixture was made for only one layer in an amount of five batches (for charging through each door). The components were carefully mixed together to give a completely homogeneous mix. Each batch was then loaded into containers, from which it was fed into the throwing machine during the movement of the latter from one door to the next.

Slagging of the bottom was commenced after the following temperature conditions had been reached (°C):

Flame temperature	1850-1950
Roof temperature	1750-1820
Hearth temperature	1680-1820
Temperature in upper part of checkers	1200-1300

Brickwork was first slagged with scale to fill up the joints and pores in the deep layers of the brickwork. The scale was spread by the throwing machine uniformly through all the doors over the banks and bottom in four stages with pauses of 15 to 20 min. Altogether, 20 tons of scale were used for slagging the brickwork. Almost the whole of it penetrated fully into the deep layers of the brickwork, this being indicated by the fact that the joints on the bottom and banks were not filled up. A small accumulation of molten slag appeared only at the tap-hole.

After this, a start was made on slagging the bottom with open-hearth slag, which was also spread in several stages by means of the throwing machine uniformly over the whole of the bottom, until practically all the joints up to the level of the sills disappeared.

The molten slag forming on the bottom was run off without keeping it any longer in the furnace. The total duration of the brickwork slagging operation was 4 hr 20 min for furnace A and 3 hr 30 min for furnace B. After the slag had been run off the furnace, the bottom had a glossy luster.

The first four layers in furnace A and five layers in furnace B were burnt-in by the usual method. The consumption of materials for this purpose was, kg:

	Furnace A	Furnace B
Magnesite powder	68,500	65,500
Scale	77,040	70,580
including:		
for burning-in the bottom	2400	2455
for burning-in the walls and banks	2640	3125
for slagging the brickwork	20,000	20,000
for slagging four layers	27,000	20,000
for slagging the thick layer	25,000	25,000
Open-hearth slag	15,040	19,580
including:		
for burning-in the bottom	2400	2455
for burning-in the walls and banks	2640	3125
for slagging the brickwork	10,000	7000
for slagging the thick layer	–	7000
Burnt dolomite	5000	7000

After the last thin layer on the walls and banks had been heated through, a start was made on the slagging of the burnt-in layers. In the course of 1 hr 40 min-1 hr 45 min in several stages, 27 t of scale was spread in furnace A and 20 t in furnace B. The heat load was increased to 48 million kcal/hr in furnace A and to 49 million kcal/hr in furnace B and was maintained at this level until completion of the burning-in process.

Slagging was stopped on the appearance of molten slag at the tap-hole. After the slag had been run off, a start was made on spreading the last thick layer of the bottom (100 mm – 70 mm). In the course of 1 hr-1 hr 45 min, 30 t of pure magnesite powder was supplied to furnace A, of which 20 t was spread on the bottom and 10 t on the banks, and 18 t was supplied to furnace B, of which 12 t was on the bottom and 6 t on the banks.

Two hours after the spreading of the thick layer, a thin layer of 5 to 7 t of burnt dolomite was spread for producing a durable, continuous top crust on the thick magnesite layer, and after burning-in for an hour, the thick layer was slagged: in furnace A only with scale (25 t for 2 hours); in furnace B, in addition to 25 t of scale, 7 t of slag was also charged. Slagging was continued until molten slag appeared at the tap-hole, when it was immediately run off.

It was found impossible to take samples of the thick layer, since the crust produced was very tough and the sampling tool slipped over it.

After the slag had been run off, the fuel and air supply was stopped and the furnace was allowed to cool off for 20-30 min. Then, without admitting gas, the bottom was covered with ore, and charging for the first heat was commenced. The total time for burning in the bottom was 46 hours in furnace A and 53 hr 15 min in furnace B.

Chemical analysis of the thin layers of the bottom and a petrographic study of samples of these layers showed that for practically identical composition of the mix, the chemical composition and structure of the burnt-in bottom was different in furnaces A and B. In the 3rd, 4th, and 5th layers of the bottom of furnace B, the MgO content was 2.0-5% less than in furnace A. In our view, this was due to the higher heat load in furnace B; the slagging components of the mix penetrated the burnt-in bottom in depth and increased its impurity content, while the top layer remained dry and friable.

The microstructure of the layers of the bottom in both furnaces is characterized by a relatively high degree of periclase recrystallization. In the coarser pieces of magnesite powder, the periclase crystals attain dimensions of 0.04-0.20 mm. Compared with the original powder, their structure is substantially more compact. In portions of the burnt-in bottom filled with a dispersed proportion of powder, the grain size of the periclase is 0.02-0.06 mm (Figs. 1 and 2).

The growth of the periclase crystals is due to their intense saturation with oxides of iron. Nonetheless, the samples disclose many pores of sizes from 0.01 to 2-3 mm. In the lower levels, the burnt-in layers are more compact. The silicate layers between the periclase crystals are situated mainly in portions of the burnt-in bed which are filled with small grains of powder.

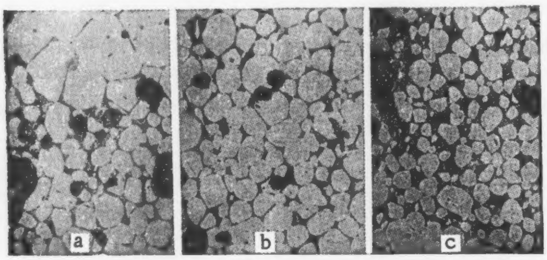

Fig. 1. Microstructure of burnt-in layers of furnace B. a) 5th layer; coarse crystals of periclase, gray parts – silicate layers, dark patches – pores; b) 2nd layer, aggregates of periclase crystals in a coarse fragment of burnt magnesite; c) 1st layer, portion filled with a dispersed component of the powder.

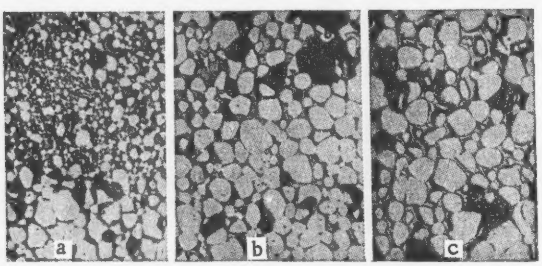

Fig. 2. Microstructure of burnt-in layers of furnace A. a) 4th layer, portion of burnt-in material filled with dispersed component of the powder; b) 2nd layer; c) 1st layer; aggregates of grains of periclase cemented by silicate interlaminations, dark patches – pores.

In the majority of cases the silicate crystals are so fine that it is difficult to determine their optical constants under the microscope. In isolated cases only is it possible to establish the presence of mervinite and monticellite by their somewhat higher refractive indices.

The burnt-in bottoms of the two furnaces showed differences in durability in service. The chemical composition of the slag of the first head indicated this immediately – in the slag from furnace A, the MgO content of the slag was normal and in furnace B it was rather high.

The bottom of furnace A withstood 70 heats without repair and was clean during the operating time. In this period, it wore away by only 35 mm. On the first repair, of the hearth, only the front and back walls were fettled, the bottom did not require repair. The bottom of furnace B after burning in withstood 50 heats and was put off for minor repair. During operation, the bottom had a dirty appearance. In our view, this was due to the use of slag for slagging the last thick layer at excessively high temperatures, which did not produce a strong crust of dolomite with magnesite powder, and the top layer of the burnt-in bottom quickly wore away.

Conclusions

The experiment of burning-in four bottoms of open-hearth furnaces at the Magnitogorsk Metallurgical Combine by the accelerated method using thick layers showed that the application of this method permits the burning-in period to be cut to one-third or one-quarter, while producing a bottom of high durability.

The first and last layers should be burnt-in with only pure magnesite powder and the intermediate layers with a mixture of magnesite powder, scale, and open-hearth slag. The open-hearth slag may be replaced by burnt dolomite, which requires an increase in the amount of scale.

The brickwork of the bottom should be slagged with scale which, due to its higher fluidity than that of open-hearth slag, penetrates the deep layers of the brickwork and fills up all the pores and joints, preventing the penetration of iron or steel into the brickwork. Slagging of the surface of the brickwork with open-hearth slag should be commenced only after complete saturation of the brickwork with molten scale.

The last thick layer of magnesite powder (100 mm) is burnt-in gradually in the first heats after burning-in the bottom. To preserve this layer, it is necessary to burn-in on it a thin layer of burnt dolomite which combines with the upper part of the magnesite layer and forms a tough outer crust, preventing the thick layer from becoming detached and floating up.

Slagging of the burnt-in bottom should be done only with scale, since if slag is used for that purpose, the top layer of the burnt-in bottom has a friable appearance in the form of "dirt" which is floated to the top during the first heat; the life of the bottom is reduced.

The heat load during burning-in should not be too high; this results in softening of the bottom, penentration of the slagging components of the charge into the deep layers of the bottom, and impairment of the sintering conditions of the upper layers.

The increase in layer thickness (100 mm) which has been attained does not appear to be the limit. The possibility of further increasing the thickness of the top layer and decreasing the total number of layers should be investigated.

MECHANIZATION OF DEOXIDIZER FEED TO STEEL LADLES

Information Bulletin of the Central Office of Technical Information
of the Stalin Council of People's Economy
Translated from Metallurg, No. 11, p. 23, November, 1960

The Engineering and Technical Workers' Collective of the Enakievsk Metallurgical Plant have evolved a method for the complete mechanization of the feed of deoxidizers to steel ladles.

A Black crusher type C-1802A is used for crushing the deoxidizers.

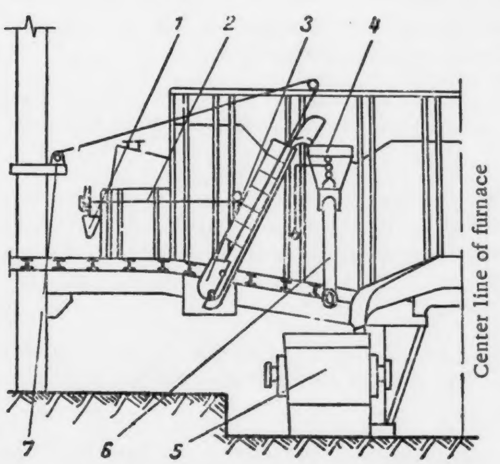

Diagram showing mechanization of deoxidizer feed to ladles. 1) Bucket; 2) monorail; 3) skip; 4) bunker; 5) steel ladle; 6) pipe; 7) electric crane.

The deoxidizers are supplied from the stockyard to a bunker mounted above a 5 ton weighing machine near the "balcony" of the charging floor, and from the bunker they are fed to a bucket (see figure). The weight of deoxidizers in the bucket is 300-400 kg. By means of the charging crane, the bucket is then suspended from the hood of a monorail mounted on brackets. The monorail carries the bucket to the back wall of the furnace. On the back wall are mounted skip elevators (one for each ladle). The deoxidizers are discharged from the bucket to the skip of the elevator. The skip is moved upward by means of a crane along two guides. The deoxidizers are discharged into a 3 ton bunker mounted between the furnace buckstays. When the metal is tapped from the furnace, a slide is opened in the bunker pipe and the deoxidizers fall into the ladle.

The bunker is filled several times, depending on the deoxidizer requirements.

Mechanization of the deoxidizer feed has facilitated the work of the steel melters and ensured the production of both high-grade and low-alloy steels.

The estimated saving in the deoxidizing of killed steel in ladles due to mechanization of deoxidizer feed amounts to more than 850,000 rubles.

COMPLETE MECHANIZATION AND AUTOMATIC OPERATION OF THE FINISHING SECTION OF STRIP MILL 300

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All-Union Scientific Research Institute of Metallurgical Machines,
Bauman Moscow Higher Technical School
Translated from Metallurg, No. 11, pp. 24-28, November, 1960

The work of modern rolling mills on the section from the delivery of the metal from the heating furnaces to the moment it leaves the rolls is as a rule fully mechanized and in the case of some mills is automatic. In the section of the removal and finishing of the rolled products, however, the problem of complete mechanization and automatic operation has not yet been solved, and manual labor is employed here not only for controlling the individual machines and mechanisms, but for a number of auxiliary operations in regard to the finishing of the rolled products (inspection, sorting, stacking, binding, packing, etc.). The realization of steps for the complete mechanization of these laborious processes is an urgent matter of primary importance.

The control figures for the development of the national economy of the USSR in 1959-1965 provide for the equipment and erection at metallurgical plants of highly mechanized and automatic rolling mills and finishing units, ensuring continuity of the technical production process.

On such mill, the continuous strip mill 300, has been designed in the All-Union Scientific Research Institute for Metallurgical Machines* for the Krivoi Rog Metallurgical Combine. This mill will roll strip of a width of up to 460 mm and a minimum thickness of up to 2 mm, and blanks (strip) for welded tubes.

In the delivery section of the mill, manual labor is eliminated altogether. This section commences with the coilers, where the strip on leaving the last stand of the mill and being cooled to 600°C on its passage over the roll-table is wound into a coil.

The mill has two coilers for coiling the strip alternately. The coil is removed by a jib crane and is placed on one of two continuously moving conveyors following the crane. Each conveyor consists of two driven plate roller chains, moving along guide rails and having solid cast cradles, spaced at equal intervals, in which the coils are placed. During transport the coils cool to 200-300°C and can therefore be loaded directly into railroad cars.

At the end of each conveyor, the cooled coil is removed by a coil lifter and is fed to the centering device of the binding machine. The coil lifter is switched on from the pulse of a photocell when the coil in the cradle comes into the range of the photocell beam.

The coil lifter is a jib crane with two jibs; one removes the coils from the conveyor and loads them alternately into the binding machines, while the other removes the bound coils and transfers them to the stacking car (Fig. 1). The speed of operation of the mechanisms is based on a maximum rolling rate of 20.1 sec.

The weighing of the coil in the centering device on the weighing machine platform is done simultaneously with the binding operation. For the mechanization of the binding process, a new design of machine has been

*The design was executed under the direction of Corresponding Member of the Academy of Sciences, USSR, A. I. Tselikov, Candidate of Technical Sciences A. D. Kuz'min, Engineers P. I. Solov'ev and A. A. Sarychev, with the participation of Fellow of the Bauman Moscow Higher Technical School A. I. Merenkov.

evolved whereby it is possible to bind rectangular strip packs and coils having a maximum cross section of 460 × 300 mm with binding wire of a diameter of 6.5-3.5 mm. A prototype of this machine made at the All-Union Scientific Research Institute for Metallurgical Machines has been successfully tried in industrial conditions.

According to the conditions of binding the variously packed rolled material, the machine can be set up either in the vertical or horizontal position, and the twisted knot of the binding wire ends is formed, respectively, either below the bound article or on one side of it.

The machine can bind rolled products with one or several wires with adjusted tension of the wire round the cross section to be bound. In binding rectangular cross sections (for example coils and strip packs), before forming the twist knot, right-angled bends are first formed in the binding wire while it is round the section.

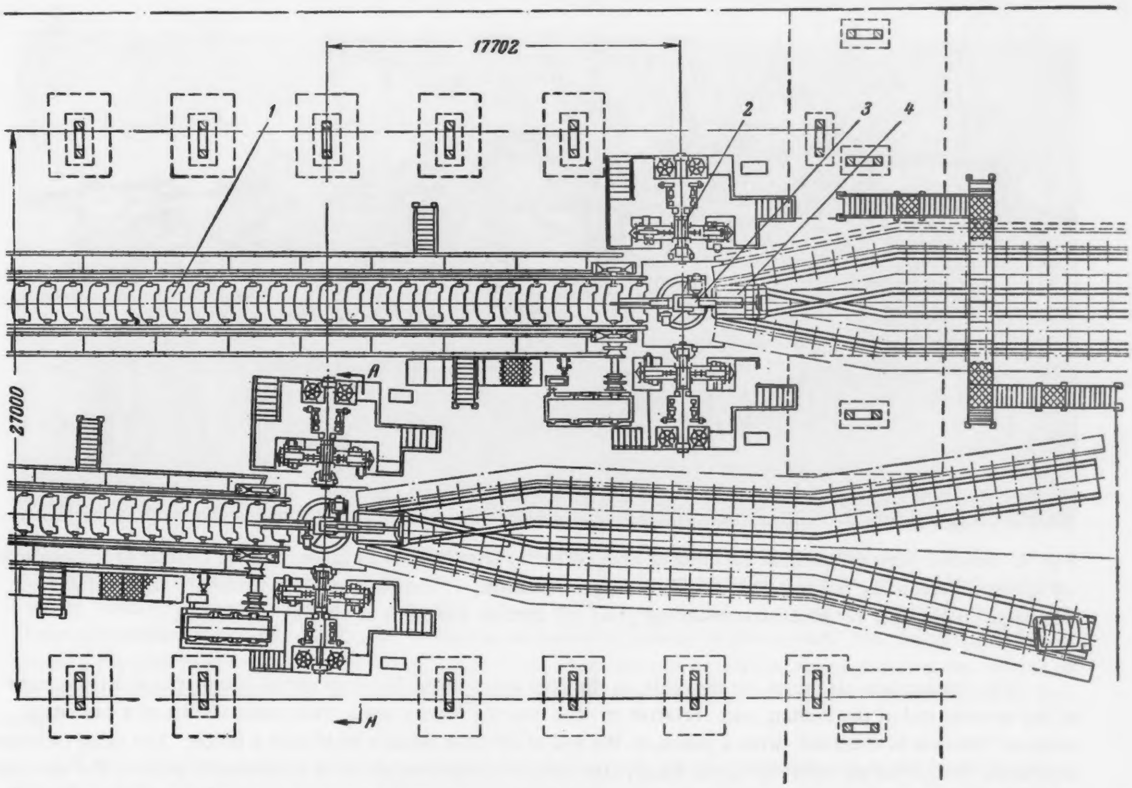

Fig. 1. Plan of coil finishing section of mill 300: 1) Cradle conveyor; 2) binding unit; 3) coil lifter; 4) self-propelled stacking car.

The mechanisms of the machine performing the various binding operations are driven individually, either electrically or by compressed air. The interconnection between them is effected automatically by means of a relay-contactor apparatus in accordance with an electric control unit.

Each conveyor is followed by two pairs of binding machines; each pair binds a coil, mounted on the centering device, at two diametrically opposite points.

Each binding machine comprises (Fig. 2) a wire holder, carrying a reel of binding wire; feed mechanism supplying a measured length of binding wire; threading mechanism for passing the wire round the section to be bound and forming the right-angled bends in the wire, and the mechanism for twisting the ends of the binding wire.

The feed mechanism comprises two dummy-roller wire-straightening mechanisms and compressed-air shears, mounted on a welded steel frame.

The wire straightening roller mechanisms straighten the binding wire, 6.5-3.5 mm diameter, in both horizontal and vertical planes. Each mechanism has five dummy hardened steel rollers, rotating on rolling bearings; three of them are stationary and two can be moved in the straightening plane for regulating the process.

The feed roller mechanism has hardened steel rollers with machined profile grooves. For feeding the binding wire in different measured lengths, corresponding to the cross section to be bound, which in their turn depend on the sort of rolled product dealt with, provision is made for controlling the number of revolutions of the rollers of the mechanism, corresponding to the transmission ratio of a gearbox connecting the feed rollers to the control apparatus, which switches the rollers off after they have fed the predetermined measured length of wire.

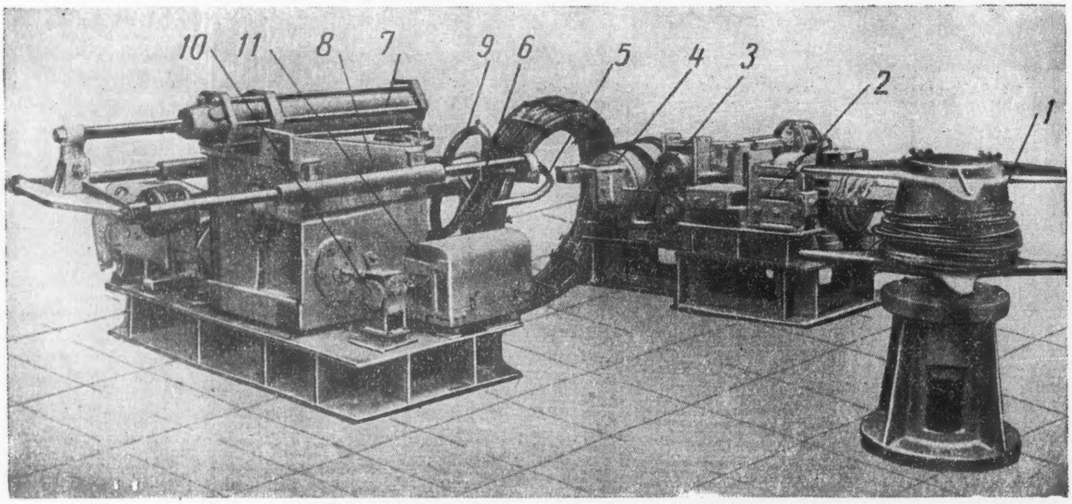

Fig. 2. General view of machine for binding strip coils: 1) Wire holder; 2) guide; 3) feed rollers; 4) compressed-air shears; 5) threading stirrups; 6) rod of threading mechanism; 7) compressed-air cylinder; 8) differential reducing gear; 9) grips; 10) kinematic reducing gear; 11) control apparatus of binding machine.

The compressed-air shears are movable on the feed mechanism frame to ensure symmetrical arrangement of the severed end of the binding wire relative to the twisting mechanism. The shears consist of a cast-steel cylinder 250 mm in diameter with a piston, to the rod of which is fixed a slide with a blade. The other (stationary) blade is fixed to the cylinder cover, which also carries the end switch for transmitting a pulse to the threading mechanism. The binding wire is fed to the shears and from them along a guide to the binding position. The working pressure of the air in the cylinder is 4-6 excessive atm.

The threading mechanism consists of two stirrups mounted in the eyes of rods moving in guides, and a compressed-air cylinder, 125 mm in diameter, connected to the rods by a fork and cross-piece. The working pressure in this cylinder is also 4-6 excessive atm. The stirrups can be moved away from and toward each other in the eyes of the rods, varying the distance between them in accordance with the width of the cross section to be bound.

The twisting mechanism consists of differential and kinematic speed-reducing gears with a control apparatus, which controls the drive of the mechanism. The twisting mechanism can also move on the frame, for selecting the predetermined distance between the grips and the strip coil.

The coil, placed by the lifter in the centering device, is bound as follows. The stirrups move to the center of the coil, whereupon the feed rollers feed the binding wire from the wire holder through the dummy straightening rollers and the compressed-air shears and through the eyes of the threading mechanism stirrups. In accordance with the predetermined program, depending on the cross section of the coil or pack, after a predetermined number of revolutions of the feed rollers, the control apparatus switches off their motor and switches on the com-

pressed-air shears. In the case of binding with a number of wires, the feeding of the wire and the severing of the measured length are repeated the requisite number of times, whereupon the threading mechanism receives from the end switch fixed to the cylinder cover a pulse for movement from the center of the coil (to the left in Fig. 2). The stirrups of the threading mechanism, while embracing the cross section, bend the binding wire along three sides of the rectangular cross section of the coil or pack; the wire is given a pi-shape (Π).

In the extreme position, the threading mechanism acts on the end switch which switches on the twisting mechanism motor. Stops are welded on to the stirrups for retaining the ends of the binding wire.

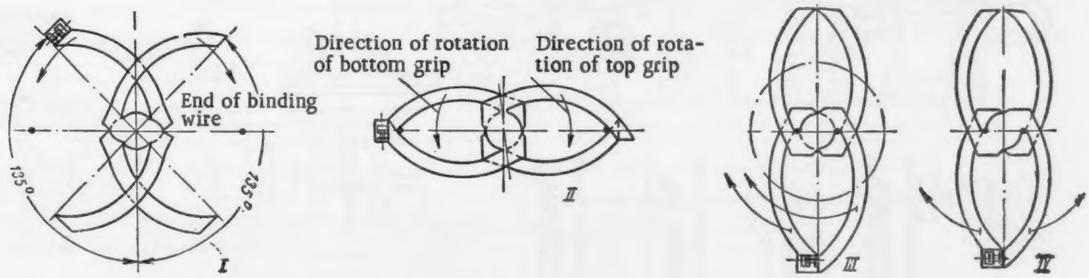

Fig. 3. Diagram showing operation of twisting mechanism: I) The two grips are moved apart by 135° from the wire-gripping position; II) bending of the wire toward the center on rotation of the grips toward each other; III) gripping and twisting of the ends of the binding wire during rotation of the grips in one direction; IV) after twisting of the ends of the wire, the twisting mechanism drive is reversed and the grips move apart back into the original position.

After the twisting mechanism motor has been switched on, the grips (Fig. 3) of the differential reduction gear, rotating toward each other, grip the ends of the binding wire, bend them away toward the center, clamp them and twist them together, making the necessary number of turns for forming a twisted knot. At the same time, the movement of the grips from the initial position to the clamping together of the wire ends is used for bending relatively to the fourth side of the cross section of the coil or pack. A complete and close application of the wire around the whole of the cross section to be bound is ensured by this means. The force applied in gripping the ends of the binding wire during the twisting operation can be varied, thus permitting the tension of the binding wire round the cross section to be regulated for a fully predetermined number of revolutions of the grips.

If the clamping of the binding wire is weak, the twist knot is formed from the ends of the binding wire protruding from the grips. If the wire does not slip between the grips, the binding knot is formed by the take-up of the slack of the wire embracing the cross section, i.e., by tightening of the wire round the bound cross section.

The choice of the optimum tension is of considerable importance, since too strong a tension may cause denting of the outer edges of the rectangular cross section, while a weak tension will not give a tight binding.

The bound coils are placed in self-propelled stacking cars running on rails. While one car is being loaded, another car is being unloaded at the end of the track (Fig. 1). The speed of the cars during coil loading is 0.3 m/sec, and during movement to the unloading station it is 1 m/sec. The supporting part of the car, on which the bound coils are placed, is at an angle of 10° to the frame with the sheel axles.

All the operations in the finishing section (coiling, conveying the coils to the binding machines, binding, stacking, and transport to the finished products stock) are fully mechanized and automatic.

For the production of measured lengths of strip from the finished products stock of continuous mill 300, a cross-cutting unit has been provided, by means of which strips in packs of a length of from 8 to 5 m are obtained from the coils. The line consists of a loading device, uncoiler, nine-roller straightening machine, flying crank-lever shears, cutting the strip moving at a speed of 1-3 m/sec, rejector for removing strips of unmeasured

length from the roll-table into collecting boxes by means of levers operated by compressed-air cylinders and controlled by photocells, piling device, and binding roll-table with transfers and weighing machine (Fig. 4).

The piler has a lifting and lowering table, which is lowered continuously at a speed of 0.38-1.52 mm/sec during stacking to ensure constant level of piling of the sheets. The speed of lift of the table is 16 mm/sec.

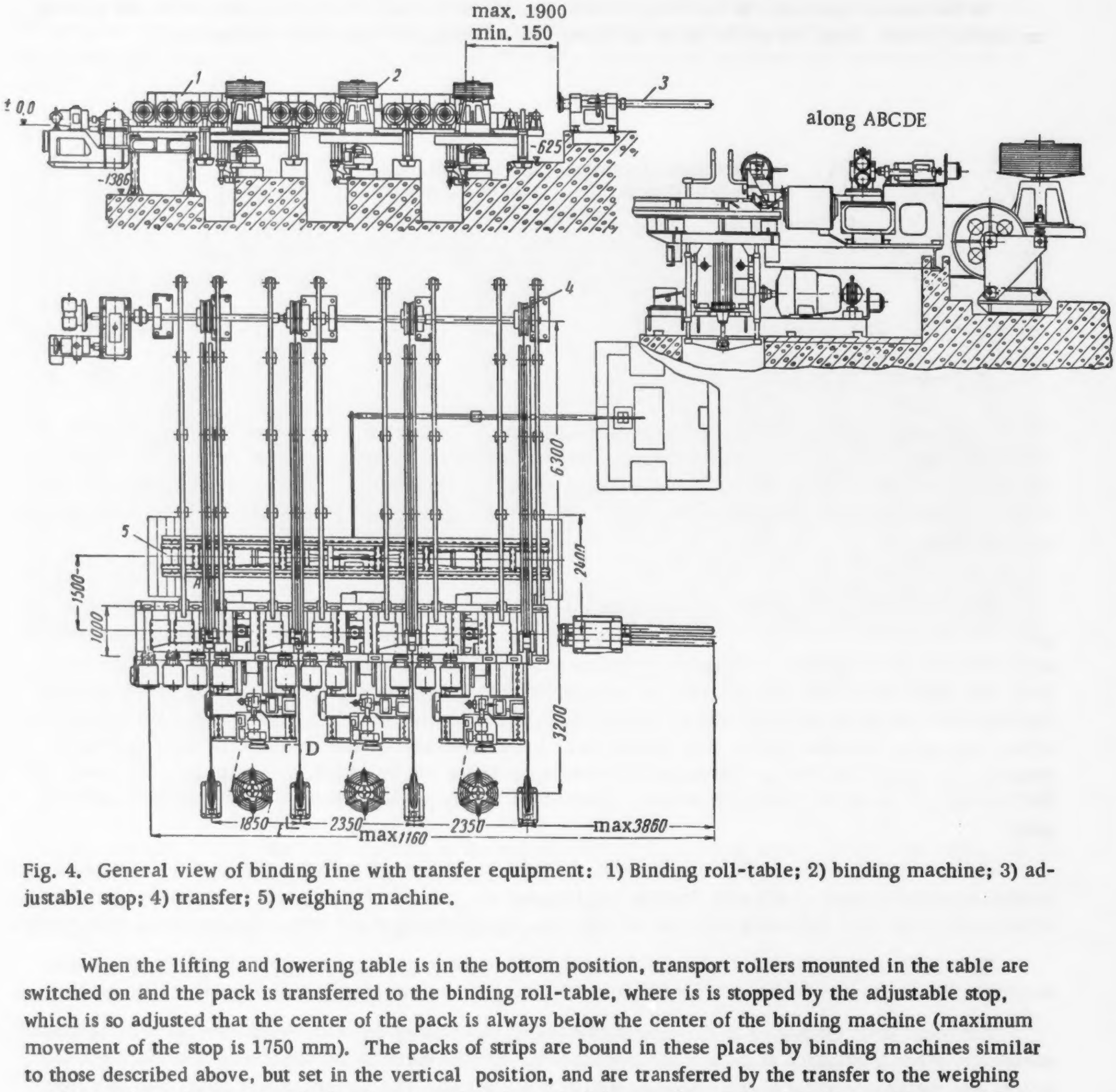

Fig. 4. General view of binding line with transfer equipment: 1) Binding roll-table; 2) binding machine; 3) adjustable stop; 4) transfer; 5) weighing machine.

When the lifting and lowering table is in the bottom position, transport rollers mounted in the table are switched on and the pack is transferred to the binding roll-table, where is is stopped by the adjustable stop, which is so adjusted that the center of the pack is always below the center of the binding machine (maximum movement of the stop is 1750 mm). The packs of strips are bound in these places by binding machines similar to those described above, but set in the vertical position, and are transferred by the transfer to the weighing machine, where they are weighed and conveyed to the end of the transfer. Following the weighing machine, there may be 7 packs in succession, which are then removed by crane.

On this line also all the operations, commencing with the loading of the coil and terminating by binding, followed by weighing, are fully automatic and mechanized.

MECHANIZATION OF THE SORTING AND PACKING OF METAL IN THE PRODUCTION LINE

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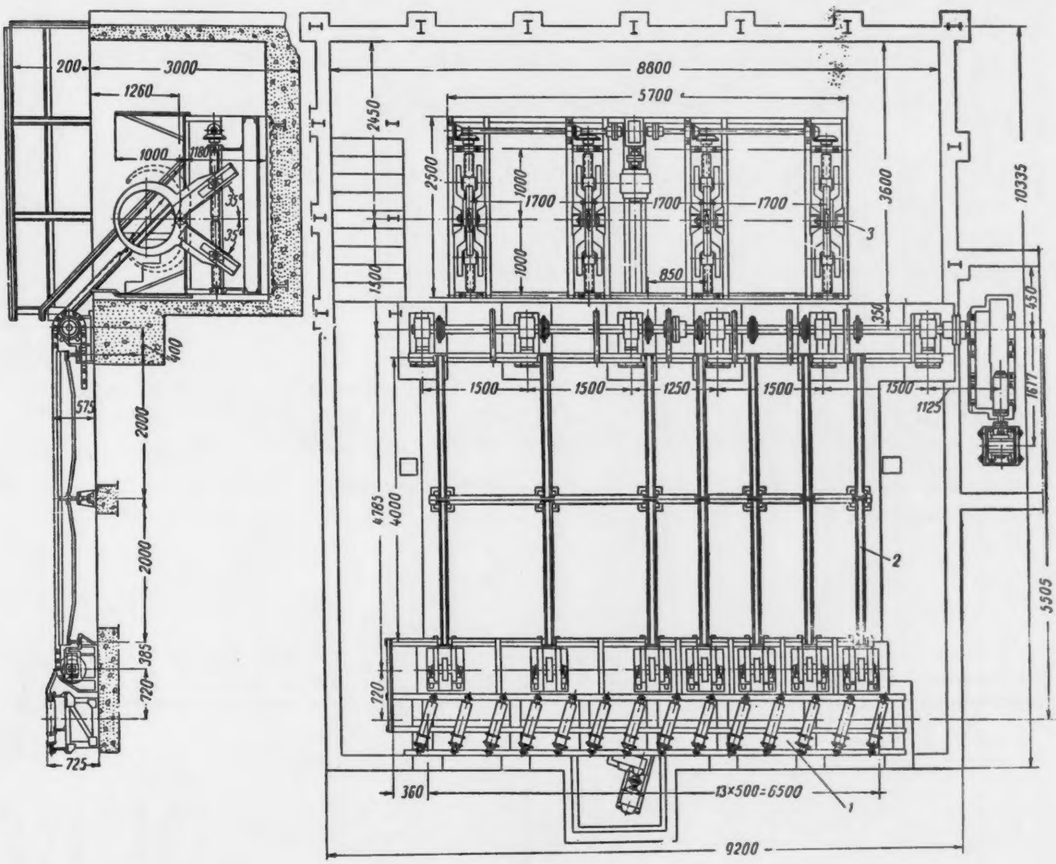
Deputy Chief of the Sorting Shop, Kuznetsk Metallurgical Combine
Translated from Metallurg, No. 11, pp. 29-30, November, 1960

The sorting of metal in rolling shops is a labor-consuming operation requiring a large number of sorting personnel. Recently, an installation has been brought into operation in the rolled-products sorting shop for the mechanized sorting and packing of the sorted metal in the production line after the straightening machine (figure).



General view of the mechanized racks for sorting metal. 1) Inclined table; 2) chain transporter; 3) container with packing equipment.

On being discharged from the machine, the work-piece falls onto a roll conveyor with slantwise rollers, which automatically discharges it onto the mechanized rack made in the form of a chain-transporter, consisting of four rows of chains, continuously moving at a speed of 0.5 m/min. Such a speed makes it possible for the workers to examine the surface of the work-pieces, check their dimensions, if necessary crop the ends and remove rejected pieces.

Then the work-pieces go into the packing installation, the jaws of which, after the container has been filled, grip the packet; after this it is tied in two places with wire and removed from the container by a crane. The jaws are opened and closed by means of screw and nuts driven by a motor through a reduction gear.

The packing installation is protected from accidents, possible in closing the jaws, by a friction clutch installed after the reduction gear, which slips when overloaded. Damaged ends of individual work-pieces are cut off with an autogenous cutting torch. Somewhat later an abrasion cutting machine will be used for cutting off.

Mechanization of sorting and packing of the metal results in a considerable alleviation of the heavy labor of the sorting personnel.

MECHANIZATION AND AUTOMATION OF ROD-WITHDRAWAL INSTALLATION OF A TUBE-ROLLING PLANT WITH CONTINUOUS MILL

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V. I. Lenin Tube-Rolling Factory

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Until recently, the withdrawal of rods from rolled tubes in the production line of a tube-rolling plant with a continuous mill has been the least mechanized process and has required the use of manual labor. Such operations as the return of the plyer, the gripping of the rod by the plyer, the coupling of the hook into the endless chain, the discarding of the withdrawn rod into the cooling bath, have been carried out manually.

In the tube-rolling shop of our factory, the operations on the rod-withdrawal installation have been mechanized and automated, and this has raised its production capacity and considerably eased working conditions (Fig. 1).

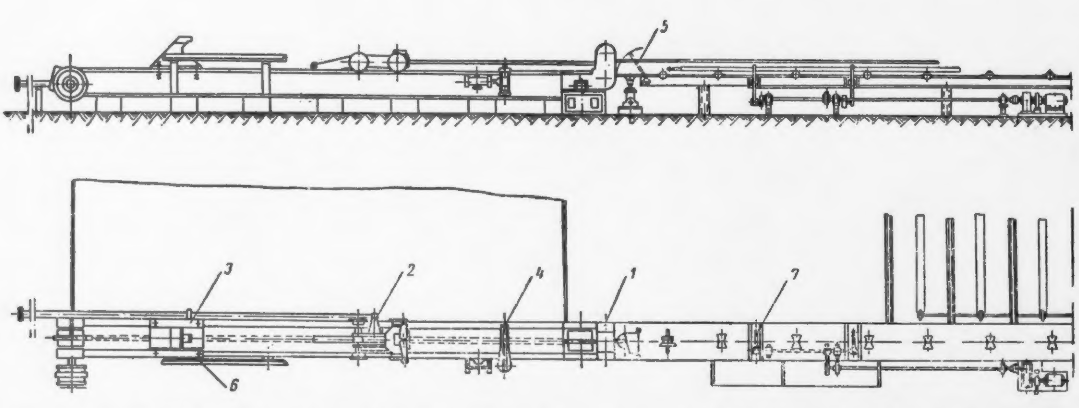

Fig. 1. General view of rod-withdrawal installation and all equipment. 1) Mechanized die-block; 2) automatic plyer with pneumatic drive; 3) uncoupling block; 4) rod discarder; 5) installation for tube-withdrawal from die-block; 6) uncoupling edge; 7) tube discarder.

Tubes and rods are fed into the die-block (Fig. 2), which secures the tubes while the rods are withdrawn. While the tubes are being brought up, the jaws of the die-block are separated by the counterweight. The coupled movement of the upper and lower jaws secured to the cranks is achieved by toothed sectors (not shown in Fig. 2) installed as brackets on the shafts.

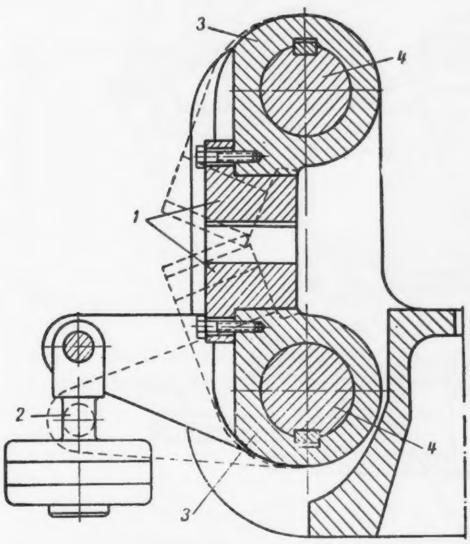

Fig. 2. Die-block. 1) Jaws; 2) counterweight; 3) cranks; 4) shafts.

However, the jaws of the die-block open so that only the rod is admitted. Under the action of the withdrawal force the jaws completely close and secure the normal working of the process. After withdrawal of the rod, the counterweight opens the cranks and jaws, thus making the removal of the tubes easier.

The jaws must be changed depending on the rod diameter. The possibility of withdrawing either one or two rods is provided.

The automatic plyer (Fig. 3) is designed for the simultaneous withdrawal of two rods from tubes. In the forepart of its body there is a mouth, in which are installed two vises with jaws. Upon meeting the rods, the vises are opened, admitting the heads of the rods, which, on striking against the end of the catch, release it from the ledge on the boss of the drawing hook. The spring pulls the lever under the catch thus excluding the possibility of coupling the catch with the ledge on the drawing hook boss during rod withdrawal. Under the action of its own weight, the hook engages in the chain. The springs bring together the vises and jaws, and the latter tightly grip the rod heads. The withdrawal process begins.

At the end of the process the roller runs against the uncoupling edge and takes out the lever from under the catch; the roller of the toothed sector, by means of the same uncoupling edge, opens the vises and jaws, releasing the rod heads. By sliding on the inclined faces of the release block, a rod disengages the hook from the chain and raises it so that the catch grips the ledge on the boss of the hook. The plyer is returned to the die-block by a long-travel pneumatic cylinder, the shaft of which is joined to the plyer through a hinge.

The uncoupling block is to uncouple the plyer hook from the chain. The body is clamped to the draw bench with bolts and can be moved on the frame of the rod-withdrawal installation depending on the length of the rod being withdrawn. The block has a buffer to take up possible impacts of the plyer hook.

When the plyer and rods have been withdrawn about 2.5 m from the die-block, the pneumatic cylinder of the rod discarder operates (Fig. 4), which turns the body of the vertical cylinder so that its lever comes under the rods being withdrawn. When the withdrawal process is completed, air is supplied to the lower cavity of the vertical pneumatic cylinder. The boss raises the lever up, along which the rods are rolled over into the bath for cooling. Then the lever is lowered, and the vertical pneumatic cylinder and lever are returned to the initial position.

After the mandrels have been removed from the tubes, the installation for the withdrawal of tubes from the die-block (Fig. 5) comes into operation. The pneumatic cylinder swings the plate, which, striking against the tubes, detaches them from the die-block and then stops in the same position. The inclined surface of the plate makes the ejection of the tubes into the container easier. On completion of the process the plate is returned to its initial position.

The discarder (Fig. 6) is designed to discard tubes after the rods have been withdrawn. Tubes with rods which had entered from the dragging device are supplied by a roll-conveyor to the die-block of the rod-withdrawal installation. After the rod heads have been gripped by the jaws of the automatic plyer, two levers of the

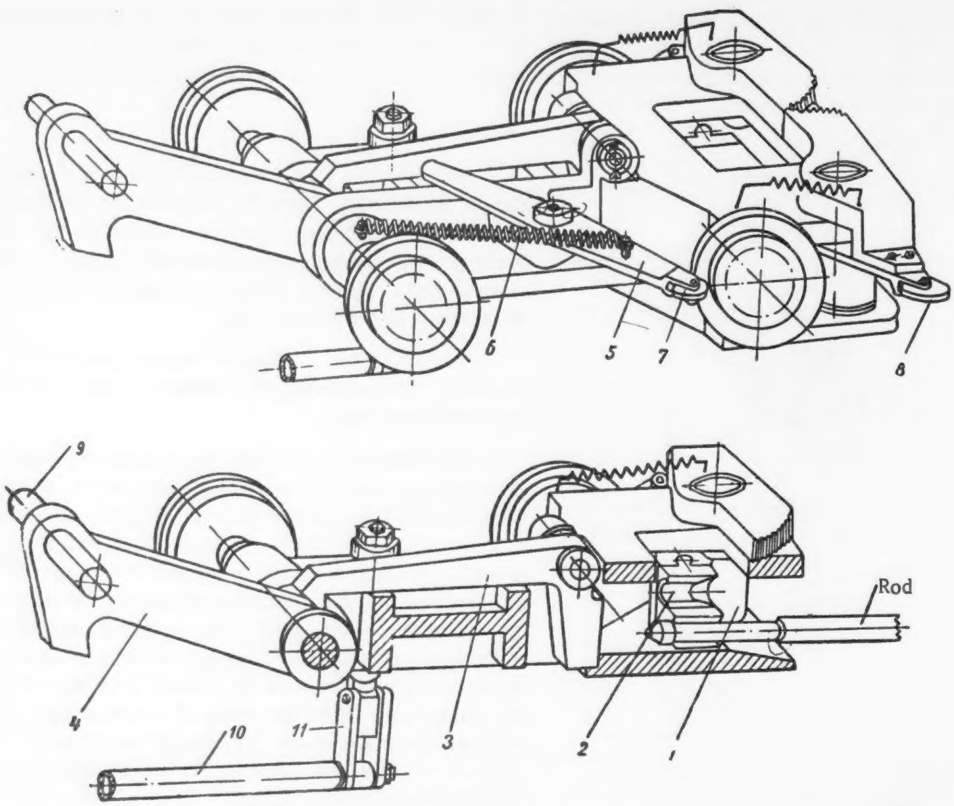

Fig. 3. Automatic plyer. 1) Vise; 2) jaws; 3) catch; 4) drawing hook; 5) lever; 6) springs; 7) roller; 8) roller of toothed sector; 9) rod; 10) shaft; 11) hinge.

discarder raise the tubes with the rods above the roll-conveyor. The levers are set up on the guide rods of a four-link mechanism and are set in motion by an electric motor. During this, the next two tubes with rods can be moved to the die-block underneath the levers. The tubes which have been freed from their rods are discarded into the container by rotating the crank of the four-link mechanism through 180°

Such a design of tube discarder has made it possible to increase the production capacity of the rod-withdrawal installation by shortening the time taken in feeding tubes to the die-block.

The operating scheme is ready to work after the knife-switches have been switched on and the crank of the universal change-over switch has been turned to "automatic". When the withdrawal of the rods from the tubes is started, the load on the main drive of the rod-withdrawal installation is increased, the maximum current relay is switched on, which closes the contact of the tube discarder mechanism.

The levers of the mechanism, in turning through 180°, are raised into the upper position; in this way the tubes with the rods are brought into the line of drawing. In the upper position of the mechanism's levers, a contactor is opened by the discs of the command-apparatus. In the process of withdrawing the rods, an earthed steel brush, set up on the plyer, closes a static contact sensing-switch and switches on a relay, which fulfills in the circuit the function of an indicator showing the direction of motion of the plyer. As soon as the plyer passes the rod discarder, the brush closes a sensing switch, and the preparation relay of the discarder is switched on. The normally open contacts of this relay switch on the discarder's electropneumatic preparation valve; its lever is swung round under the rods.

With the switching-on of the discarder, the relay and electromagnetic valve of the mechanism for timing the mandrels in the bath (on their being discarded) goes into action. After the rods have been withdrawn, the

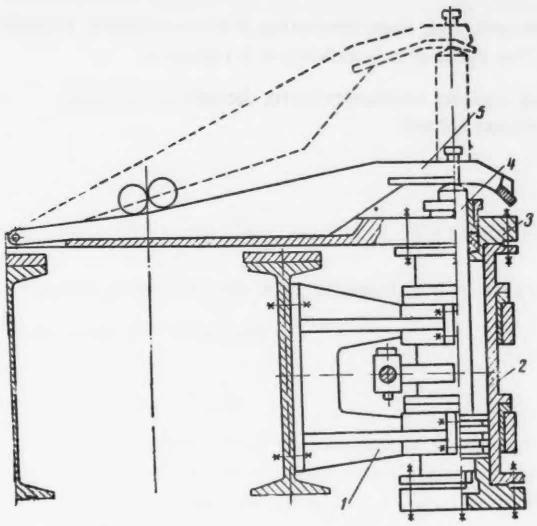

Fig. 4. Rod discarder. 1) Pneumatic cylinder; 2) vertical cylinder; 3 and 5) levers; 4) boss.

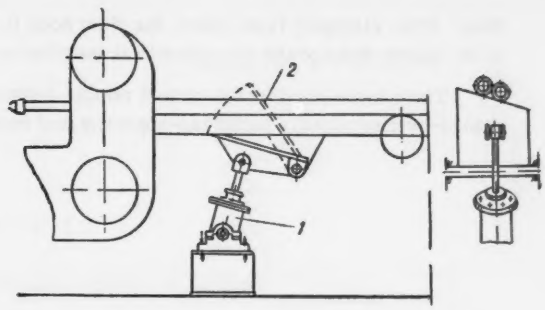

Fig. 5. Installation for withdrawal of tubes from die-block. 1) Pneumatic cylinder; 2) plate.

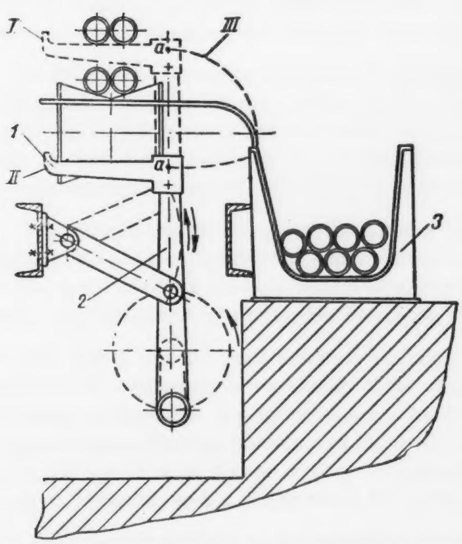

Fig. 6. Tube discarder. 1) Lever; 2) guide arm; 3) container.

brush closes the sensing switch of the tube discarder and the relay, the electropneumatic valve of mechanism for withdrawing the tubes from the die-block and contactor are switched on.

The discarder mechanism, on being turned thru another 180°, discards the tubes into the container and comes down to its lowest position. The discs of the command apparatus in the lowest position of the mechanism break the circuit of the contactor supply. With further movement of the plyer, the brush closes a sensing switch, and the relay and electropneumatic valve of the rod discarder are switched on; the rods roll down into the cooling bath.

Simultaneously, the normally open contacts of the relay switch on the electropneumatic valve of the long-travel pneumatic cylinder for the withdrawal of the hook. Compressed air is supplied to the right cavity of the pneumatic cylinder, acceleration is imparted to the plyer, and the hook is decoupled from the rollers on the endless drive chain. With further movement of the plyer, the brush closes a sensing switch and the relay of the final cutoff of the travel of the plyer backwards (from the die-block) is closed. The normally closed contacts of the relay break the supply circuit to the relay; the electropneumatic valves are closed. The rod discarder is returned to its initial position.

Although the supply of compressed air to the right cavity of the long-travel cylinder is discontinued, the plyer continues to move under the action of inertia forces toward the uncoupling block, set up on the frame of the rod-withdrawal installation. By means of the block, the hook is raised up and is held in this position by the catch. As soon as the rods take up their correct position on the inclined rack of the bath for cooling, the electropneumatic valve of the rod timer is opened. The plyer is returned to the die-block by the command-apparatus on rotation of its handle into the "forward" position. For this, the electropneumatic valve of the plyer return is closed and compressed air is fed into the left cavity of the long-travel cylinder. At the die-block, the brush closes a sensing switch, closing one relay and opening another. Upon setting the handle of the command-apparatus into the zero position, the plyer stops as soon as the ends of the next rods enter its clamp

vises. When clamping takes place, the plyer hook is released, and, under the action of its own weight, engages in the driven chain of the rod-withdrawal installation. The cycle of rod-withdrawal is repeated.

The scheme provides for manual remote control by separate mechanisms with the help of universal change-over switches, a command-apparatus,and push-button control.

AUTOMATION IN THE METALLURGICAL INDUSTRY

A SURVEY BASED ON THE PROCEEDINGS OF THE FIRST INTERNATIONAL CONGRESS ON AUTOMATIC CONTROL

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The Secretary of the "Automation of Metallurgical Processes"
Section of the First International Congress of IFAC
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The First International Congress on Automatic Control, arranged by the International Federation of Automatic Control (IFAC), was held in Moscow from June 27 to July 2, 1960. The Congress constituted an important event in the development of the theory and techniques of automatic control and attracted the attention of automation specialists employed in various industries. The Congress was attended by about 2000 delegates and guests from 26 countries who heard and discussed about 300 papers devoted to various problems of automatic control.

In the section on the automation of metallurgical processes 15 papers were read (8 Soviet and 7 foreign). The main subjects discussed were various problems of the automation of rolled-steel production, and in addition some papers were devoted to the automation of blast-furnace production and heating facilities at iron and steel works. An outstanding feature of the automatic control systems described in the papers presented was an extensive application of computers, self-adjusting elements, and flexible programming.

Well-known English experts on the automation of rolled steel production, N. Bramley, S. Carlisle, and R. Sims, presented a comprehensive paper with a description of equipment for the automatic control of dimensions and speed of rolled metal, a system of automatic control for hot-rolling mills, and the "Translator" system – a programmed control system for rolling mills.

The British Iron and Steel Research Association has developed a number of optical and photoelectric instruments for continuous measurements of the dimensions of rolled sections. These instruments have been successfully employed at iron and steel works and have ensured a high quality of the rolled product. The new principle of contactless measurement of the speed of rolled steel, proposed by the British Iron and Steel Research Association, makes it possible to develop rolling-mill automatic-control systems which adjust the speed of rolls accurately according to the conditions of the rolling process.

An important problem in the automatic control of hot-rolling mills is the control of the thickness of the strip. The paper contained a description of a system for the indirect measurement of the thickness of the strip and a method of adjusting the thickness by changing the distance between the rolls without a time lag. In conclusion the authors reported a system of programmed control for rolling mills in which, out of a hundred possible programs of reduction, one is selected automatically depending on the final and initial dimensions of the stock and also in accordance with the steel grade.

The paper by A. B. Chelyustkin (USSR) was devoted to the application of computers in the automatic control systems of rolling mills. The paper gave a description of a system of programmed control for the screw-down mechanism at a reversible hot-rolling mill, a control system for the speed of delivery, a control system for the temperature in separate zones of the continuous furnace, control systems for the thickness of rolled stock at hot-rolling mills and cold-rolling mills, the control of flying shears and a coordinated control system of the

ingot car and cranes of soaking pits. The application of the computers in these control systems improved the quality of the product substantially, increased the output of the plants, and reduced steel wastes. In addition, the use of computers makes it possible to design quick-response and accurate control systems based on the principle of disturbance compensation (for instance, fluctuations in the thickness of the rolled piece). The computers ensure that the control systems can be adapted to varying external conditions, that is, they make it possible to design self-adjusting systems and maintain most economic operating conditions.

Dr. U. Miller, the head of the rolled-steel section of General Electric, a large American electrical engineering firm, in his paper, considered the automation of the rolled-steel industry in general. The author described a system of automatic programmed control for reversible hot-rolling mills, with 12 basic operations, carried out according to a present program set up by the operator, depending on the initial and final dimensions of the material. Dr. Miller quoted data on a new design of screw-down mechanism for the rail-structural stand, without mechanical connection between the rolls so that each roll can be adjusted separately. The paper contained a description of an interesting system of controlling the thickness of the strip on a 6-stand group of a hot-rolling mill. The system ensures an extremely small deviation in the thickness over the whole length of the strip. In addition the author discussed the problem of the analysis of process data which is an important aspect of the operation of modern automatic systems. In conclusion, the author quoted data on the utilization of computers in rolling shops. In answer to questions, U. Miller mentioned that, in his view, the economic effect of full automation is obtained above all on account of an increased output of the plant and an improved quality of the product and not by a reduction in the operating personnel.

Soviet authors, N. S. Nikolaev and V. L. Épshtein described a digital computer for the automatic control of the cutting operation of flying shears. The machine calculates the total length of the strip before the cut and determines the program for the most economic cutting, and also controls the shears automatically in accordance with this program. The computer records the weight of steel rolled and makes a repeated automatic cutting possible. The authors reported the results of commercial tests on the computers.

M. Foissen (Belgium) devoted his paper to the automatic control systems of screw-down mechanism for blooming and slabbing mills, in which the memory units have no present programs. The self-adjusting program determines the magnitude of the reductions in each pass and the number of passes required for rolling a given ingot. In the course of rolling, the initial program is adjusted by comparing the actual load of the motor with the permissible load. If the motor is overloaded, a program which corresponds to smaller elongations per mass is automatically selected. This system has an advantage over the "translator" system in its substantially smaller dimensions of the "memory" equipment. The economic effect is achieved by less wear of rolls, by increased output of the mill, and by making the work of the operator easier. The system is suitable for mills with a wide range of products.

N. N. Druzhinin, a Soviet expert on the electrical equipment of rolling mills, presented a solution to an important problem of the mathematical representation of the multimotor electric drive for continuous rolling mills, this representation being essential for the design of fully automatic systems for these complex units.

M. M. Brozgol' (USSR), using one of the iron and steel works as an example, described a system of automatic electric drive for the most important plants in the complete metallurgical cycle. The control systems of the drives constitute complex standard units which have been improved substantially and which ensure a much higher reliability and a higher output of the plants.

The automation of reversible cold-rolling mills for nonferrous metals was reported in the paper by V. I. Feigin (USSR), in which he described a pulse system of controlling the thickness of the strip by means of isotope sensors of thickness, a system for the automatic stopping of the mill, and a system for the automatic control of the pressure of the metal against the rolls. The first system controls the thickness of the strip by varying the length of a time during which the motors of the screw-down mechanism are switched on, and the second system ensures the selection of the most economic moment when the deceleration of the mill is to be started and provides for the control of the deceleration regime in accordance with a preset program. The system for controlling the pressure of the metal against the rolls permits the selection of the best reduction regimes and ensures that the rolls are protected from fracturing. The paper contained some data on the economic effect of the application of the above systems.

K. Schneider and V. Litterscheidt (West Germany) in their papers discussed the problems of the automation of heating facilities at steel-rolling shops. The first paper described an investigation of the characteristics of the cells of soaking pits by means of an electronic model. The investigation provided a solution to the problems of automatic control for the thermal regime of soaking pits. V. Litterscheidt described some general problems of the automation of industrial heating furnaces. The author defined the requirements which have to be met by automatic furnace control systems and discussed examples of control schemes for furnaces,pointing out the factors determining the selection of the control systems and types of control elements. The paper also contained a description of the characteristics of the burners, control elements,and general problems of the mechanization and automation of charging and discharging operations at the furnaces.

The paper by Yu. E. Efroimovich (USSR) was devoted to the full automation of the steelmaking process in electric-arc furnaces. For the solution of this complex problem a number of new instruments for controlling, regulating and studying the process of electric-arc furnaces was developed. These new devices include a model for measuring the resistance, voltages,and power of the arc, a computer for controlling the process of the electric power supply to the furnace, an electronic-dynamoelectric regulator for shifting the electrodes, an automatic model for the study of the electrical regime of electric-arc furnaces, thermocouples for measuring the temperature of the internal surface of the lining, an instrument for measuring and controlling the quantity of oxygen supplied to the furnace, an instrument for measuring heat losses from the furnaces, and an automatic digital system for the automatic recording of a number of process parameters. The investigations which were carried out established the rules which govern the variation of the temperature of the metal in the course of melting and which ensure a better quality of the steel. The introduction of some individual elements of the full automation system of electric-arc furnaces has already ensured a substantial improvement in the operation of furnaces.

W. Zuhlsdorf (East Germany) dealt, in his paper, with the problem of the automation of the charging operation at blast-furnaces and low-shaft furnaces. He also discussed a number of systems for automatic charging including the system of charging the blast-furnace involving the automatic change of program; a system of automatic loading and charging of materials into low-shaft furnaces equipped with a suspended track and controlled from the central control room; a system of fully automatic loading and charging of materials in which the program is selected by the controlling computer; and, finally, a fully automated transporter system for charging materials to the furnace. In all these systems,batch weighing of the components of the charge is employed. The paper described an original design for a revolving stock indicator which makes it possible to measure the level of the stock at various points at the furnace top. In conclusion, W. Zuhlstorf quoted data on the economic effect of the introduction of automatic charging systems. The paper was followed by a film showing the achievement of the German Democratic Republic (East Germany) in the field of automation of blast-furnace production.

The paper by the Soviet authors M. I. Korobko, B. G. Mikryukov, and K. A. Shumilov was devoted to improvements in the system of automatic control and regulation of the distribution of blast to the tuyeres of the blast-furnaces. The authors described a new electric system for controlling the blast rate which ensures the maintenance of the required air rate through the tuyeres by means of the redistribution of the air among the tuyeres at a constant total air input or by changing the total air input. The advantages of the proposed system lie in the lower capital cost of the equipment, a reduction in the size of the equipment, the possibility to preset different blast rates for individual tuyeres, and the application of the electric system instead of the usual hydraulic or pneumatic instruments.

The paper by Ma Chu-wu, Chu Ch'i-chang, and Huang Tsu-ju (People's Republic of China) deals with the problems of the application of controllers involving thermal feedback at iron and steel works. The authors also gave an analysis of the characteristics of flow-, temperature-, and ratio-controllers. These controllers are already in operation in a tube furnace of coke oven shops and in the soaking and reheating furnaces of a rolling shop. The authors pointed out the advantages and disadvantages of the controllers and described the design and the method of manufacturing the thermal elements. The application of these simple controllers in several cases gave good results,in addition to a substantial reduction in the cost of the equipment.

The discussion,which took place in a very businesslike and friendly atmosphere, showed that the majority of the papers presented at the Congress constituted a serious scientific and practical contribution to the solution of the automation problem in the metallurgical industry.

The proceedings of the Congress on Automatic Control show that a further development in the automation of the metallurgical industry is possible only if use is made of recent advances in various fields of science and technology. Automation is a difficult and complex process and for its introduction it is essential to have a coordinated modernization not only of the means and methods of automation, but also of technology and mechanical engineering. At the present stage of the development of the theory and technique of automatic control, it has become necessary to apply entirely new principles to the development of the technology, the equipment, and the organization of production. The final task is the establishment of a fully automated production which would ensure the best economic operation for given conditions. The results of the work of the Congress will help in the further development of automation in all branches of industry, in which the metallurgical industry takes one of the leading places.

THE USE OF COMPUTERS IN THE PLANNING AND ANALYSIS OF PRODUCTION IN THE IRON AND STEEL INDUSTRY

S. S. Filippov

State Planning Commission of the USSR
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At the end of June, 1960, a scientific conference was held at the Sergo Ordzhonikidze Moscow Engineering and Economic Institute to discuss the problem of improving the planning, control, and analysis of production with the use of computing machines and mathematical methods in the basic production shops of iron and steel works.

The conference was attended by a number of people from National Economic Councils, metallurgical establishments, Institutes, State Departments, and Government bodies. There were presented very interesting papers and reports on the application of the methods of linear programming in the planning of metallurgical production, on the improvement of planning, keeping records and controlling steelmaking and rolled-steel production with the use of computing-and-punching machines (exemplified by the "Serp i molot" Moscow Metallurgical Works), on the organization of industrial cooperation between the Magnitogorsk Metallurgical Combine and the Chelyabinsk Tractor Works on the basis of linear programming, on the application of mathematical methods in the distribution of work among rolling mills, on the method of continuous analysis and control of the operation of the blast-furnace by means of mathematical formulas which define the course of the process and the changes in the economics of the production, and several other papers.

During the discussion of the problem of the application of methods of linear programming to the planning of metallurgical production, it was stressed that the enormous scale of modern metallurgical establishments and the complex internal and external relations require an improved method of planning. One of the advanced and promising aspects in this problem is the application of mathematical methods, first of all the method of linear programming. This method is suitable for finding the optimum variant of a plan if there are several possible variations, if the conditions to which this plan has to conform are known, and if the criteria for the determination of such an optimum are established. Linear programming has already been applied in the metallurgical industry in several countries. Recently this method has attracted the attention of a number of workers in the iron and steel industry in our country.

Cand. Econ. Sci. Ya. T. Gerchuk (Moscow Steel Institute) reported that linear programming has been applied in the following fields of planning:

a) the solution of the problem of selecting the optimum components satisfying specified technical requirements with regard to composition and properties;

b) the preparation of a schedule for the distribution of work among various types of equipment to provide for the maximum utilization of the equipment available;

c) the establishment of an optimum schedule for the transportation of the same type loads from given dispatch places to the required destinations by routes which would ensure the minimum movement of stock;

d) the determination of a method of cutting materials which would ensure a minimum cutting waste.

The determination of the optimum components for the metallurgical charge for various processes involves the selection of such a combination of various components of the charge which would, first of all, ensure the production of a final metal of the required chemical composition, would satisfy the technical requirements, and would ensure the necessary output and economic production.

For the solution of this complex problem the University of California (USA) developed a model in which the above conditions are expressed in the form of mathematical formulas and which makes it possible to determine the optimum, i.e., the cheapest, charge which would satisfy all the requirements. Satisfactory results were obtained when this model was applied in practice to the selection of the charge for the blast-furnace, open-hearth furnace, and electric-furnace processes, taking into account the specific features of each process. Satisfactory results were obtained.

The application of the method of linear programming to finding the best distribution program for the production of various types of equipment in the metallurgical industry is of great importance in rolled-steel production. A mathematical model of this problem has also been developed. Its application in practice is made difficult by the absence of the required reliable productivity standards of various mills, with different ranges of rolled steel products. One of the important features of the linear programming method for the solution of those problems is the possibility of determining the optimum specialization of rolling mills, taking into account the variation in the output of the mill depending on the type of product and on the distance covered during the transportation of rolled steel to the places where it is required.

The problem of establishing an optimum transportation plan in the metallurgical industry has been solved, as it should, in relation to the rationatization of the transportation routes of similar types of goods (iron ore, coal, etc.). Thus, for instance, in England the method of linear programming was used to establish the optimum schedule for transporting coal from 154 mines to 65 coke-oven batteries. This schedule reduced the total mileage by 10% and resulted in a substantial annual saving in the transportation cost.

Substantial savings of steel can be achieved in the national economy by the application of linear programming to the cutting operations of the rolled product. Of course, these savings are most significant first of all for the consumers of steel in the machine-building and metal-working industries; but in the metallurgical industry itself, one can achieve a substantial economic effect by rationalizing the cutting of expensive coiled materials, such as cold-rolled steel, into strips and sheets. A model for the solution of this problem has been developed and is ready for use.

Linear programming can be applied to any calculation method including manual counting. However, practical problems which are of any importance can be solved by this method only with the use of modern quick-response electronic computing machines. During the consideration of the problem of improving planning, recording, and control in rolled-steel production with the use of computing-and-punching machines, it was noted that the planning work in rolled-steel production is divided into three consecutive stages:

a) analysis, summary, and grouping of all orders for the current quarter or month and calculations of the work on individual rolling mills;

b) establishment of the optimum sequence of putting orders into production;

c) recording and check on the completion of the plan with regard to the orders.

The computing-and-punching machines can select and systematize all the data required for the planning. However, the main task of the planning – the selection of the optimum sequence of rolling for all the orders in a given period – can be solved by means of linear programming with the use of mathematical methods and electronic computers.

The project for the mechanization of the analysis of production and planning data for the steel rolling mills at the "Serp i molot" Works,developed by the Research Laboratory of Economics and Production of the Moscow National Economic Council attached to the Ordzhonikidze Moscow Engineering and Economic Institute, envisages the following operations: the mechanical analysis of the orders for each mill 12 days before the beginning of the new month; the recalculation of all orders for each mill in terms of tonnage taking into account corresponding difficulty coefficients; the calculation of the work load of each mill taking into account the work requirements of each product on the basis of the tabulated data for rolled steel; the mechanical analysis of reports on the dispatch of steel product according to grades and according to National Economic Councils; the analysis of the data on progress towards the completion of orders including a summary every 5-7 days; the printing of the order file in tabulated form 12 days before the beginning of the new month.

The project was developed to be suitable for use on the 45-column machines available at the "Serp i molot" Works,and this limited the possibility of solving a number of problems of production planning. The use of 80-column computing-and-punching machines extends the scope of mechanical analysis of planning and reporting documents. It should be pointed out that the adoption of digit printing machines will make it possible to simplify the analysis of primary documents and the reading of the tabulated results.

The application of computing-and-punching machines at the "Serp i molot" Works made it possible to establish the dependence of the duration of the heat on the type of steel produced, and on this basis to develop the "difficulty coefficients." Also, the effect of several other factors on the economics of steel production was established and the optimum conditions for steel melting were developed.

The results of the work which has been done on the improvement of planning, control, recording, and analysis with the use of computing-and-punching machines are being introduced at steel-melting shops at the "Serp i molot" Works and may be recommended for other metallurgical Works in our country.

In the report on the organization of industrial coordination between the Magnitogorsk Metallurgical Combine and the Chelyabinsk Tractor Works regarding linear programming, it was pointed out that at present it is essential to extend integrated production methods in the industry not only as applied to individual establishments,but to the industry as a whole. In the first place this refers to industrial coordination between the producers and consumers (for instance between metallurgical and machine building works). This coordination assists in systematizing the work, improving regular operation and increasing the turnover of means of transport, reducing the stock of spare materials, semi-products, and finishing products, and making a substantial amount of capital and materials available.

The change to coordinated production means that machine-building works must change their present methods of production planning within the works themselves. Instead of planning the operations from the assembly to the procurement department, the work of the procurement department should now be based on the steel delivery dates; the completion schedules in the processing shops should be determined accordingly and the complete state of operations at all the stages of production should be established. At the same time, it should be taken into account that various articles can be made from a given steel material (grade, type, section, dimensions) and also that the processing of these articles may coincide. Therefore, one should find the optimum conditions for coordinating the delivery dates, which depend on the production schedule of the metallurgical establishment, with the completion dates of various stages at the shops of the machine-building works. By its nature this problem can be completely solved by means of linear programming.

The known methods of solution were applied at the cold-pressing shop of the Chelyabinsk Tractor Works on the basis of the delivery dates for the plate steel from the Magnitogorsk Metallurgical Combine.

Large-scale calculations show that as a result of the change to coordinated, production planning within a single Economic Region, one can expect about 40,000 tons of rolled steel to be eliminated from circulation.

It was mentioned at the conference that the method of linear planning makes it possible to determine the minimum time required for the completion of an order by existing rolling mills, and also makes it possible to determine the optimum solution of the problem, taking into account such factors as the erection quantity of the rolled product, the delivery date, the loss of time during the change from the production of one shape to another, the delivery distance to the consumer, etc.

During the discussion of the problem of the analysis and control of the production statistics of the blast-furnace process by means of mathematical formulas describing the process and the variations in the economics of the production, it was pointed out that the thermal equivalent of oxides or elements which constitute the charge materials can be employed in the calculation of the economic and technical characteristics of the blast-furnace process. The value of the thermal equivalent can also be used for the metallurgical evaluation of raw materials and fuel for the blast-furnace process. Calculations can be carried out accurately and without difficulties by means of the proposed equations for the calculation of the specific consumption of coke and natural gas.

During the discussion of the problem of the analysis of the cost of metallurgical production by means of analytical computing machines, the contributors at the conference pointed out that the most difficult and laborious calculation is the analysis of the completion of the plan according to the cost of production of metallurgical works and the individual basic shops – blast-furnaces, steelmaking and rolling shops.

The use of computing-and-punching machines makes it possible to set up and carry out production analysis in the course of the process of establishing the cost of pig-iron, steel, and rolled products, and so may actively influence the course of carrying out the plan according to the production cost, and to take measures to ensure economic operation.

The analytical and computing machines can be used for carrying out all the calculations necessary for the study of the economics of the production and the development of planned operations in any combination; the determination of the total sum of savings or overspending in individual productions sections, shops, and whole establishments, and the weighed-mean percentage change in cost, the determination of the effect of consumption coefficients and prices on the cost of products; the determination of the effect of any change in the composition of material consumed, in the fuel and energy consumption on the cost, etc.

For the utilization of the analytical machines with the object of the technical and economic analysis of the cost of metallurgical production it is necessary:

a) to establish adequately developed and technically justified standards of the utilization of the equipment, labor, consumption of materials, fuel, and power;

b) to develop in detail the form and methods of recording technical and process data, which should include all informations required for subsequent analysis by means of computing machines;

c) to establish a definite code system necessary for the punching of cards and their subsequent processing;

d) to ensure an adequate throughput capacity of the computer sections and to provide them with modern computing equipment.

The use of calculating machines and mathematical methods makes it possible to eliminate to a great extent the shortcomings which still exist in the treatment of the technical and economic analysis of production processes.

PROBLEMS OF MECHANIZATION AND AUTOMATION RECEIVE THE FULL ATTENTION OF THE PRODUCTIVITY COUNCIL

N. Kiyuchikov

Chairman of the Trade Union Works Committee at the "Dneprospetsstal'" Works

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The Shop and Works productivity meetings at the "Dneprospetsstal'" Works have been held occasionally for several years, but in recent years the meetings have been held infrequently and irregularly and the attendance of workers at the meetings was poor. After the December (1957) Plenary Meeting of the Central Committee of

the KPSS (Communist Party of the Soviet Union) and the 9th Plenary Meeting of the All-Union Congress of Trade Unions, the Permanent Productivity Meetings (Councils) were set up and their activities assumed new vigor.

159 men, including 100 manual workers – innovators, outstanding workers, and inventors – have been elected to the Works Productivity Council. Technical staff, representatives of the Party, Trade Union and Komsomol Organizations, and Scientific and Technical Societies take part in the work of the Council. Members of the Council include D. Galushko, a steel melter; N. Buinyi and V. Ivanchenko, leaders of the Teams of Socialist Labor; Comrade Zyukin, roll lathe operator; Comrade T. Troyanov, a rolling mill operator; Comrade Bush, an annealing furnace operator at the Thermal Treatment Shop; Comrades Salambash, Omel'chak, and Nesterenko, forge shop operators; Comrade Lobarev, head of the Rolling Shop; Engineer Speranskii, head of the Technical Department, and other workers.

The plan of activities of the Productivity Councils is prepared by the Presidium of the Council and the General Productivity Commission of the Trade Union Works Committee, and is approved by the Trade Union Works Committee. The supervision of the carrying out of suggestions of workers and the resolutions of the Productivity Councils is taken up by the management as well as by the Presidium of the Council. A check of the progress is effected mainly by means of reports to the Administration, Presidium, and Trade Union Staff on the completion of proposed measures, as well as the reports of the Administration at the meetings of the Trade Union Committee, conferences, meetings of Leading Workers, and other meetings.

The most important task of the Council is to encourage the personnel of the establishment to complete the 7 Year Plan ahead of schedule. After the June Plenary Meeting of the Central Committee of the KPSS, a meeting of the Council was held in July, 1959, at which the 5 year plan for the mechanization and automation of production processes at the Works was discussed and established. As the basis for this plan the Council took the obligation which has been undertaken by the personnel to achieve in 1963 the output planned for 1965 (1965 is the last year of the 7 year plan). The plan envisages the introduction of 90 important measures regarding the mechanization and automation of the production processes, an improvement in the quality of the product, a reduction in the production cost, an increase in operating efficiency, improvements in the working conditions, and improvements in safety.

In particular, it is planned to modify and modernize some electric steel-melting furnaces, to build a new, large-capacity vacuum equipment for the treatment of liquid steel at one of the steel-melting shops, and to build two large capacity electric furnaces at another shop; to install a pneumatic mailing system for transmittance of samples to the rapid-analysis laboratory including the automatic recording of the result of the analysis at the furnace panel; to make and install stators for electromagnetic mixing at two electric steel-melting furnaces; to mechanize the loading and unloading of the nonmagnetic components of the charge and ferroalloys in the steel-melting and scrap-preparation shops; to automate the cooling-water system at a number of furnaces; to modify the delivery platforms at the 550 steel-rolling mill, and to replace the cast frames of the first and second stand with steel frames including mechanized screw-down mechanisms and mechanized lift for the lower rolls; to mechanize the entry of the stock into the last stand of the finishing line of the 325 rolling mill; to automate the operation of the reheating furnaces and cold-cutting shearts; to develop manufacture and install forging manipulators for the 2-ton and 1-ton hammers at the forge shop; to mechanize the entry of the wire rod to the shaping mills, thus eliminating the operation of pointing or rapering the rod ends; to introduce the automation and telemechanization of the electric substations at the Works, etc.

The Presidium of the Council (consisting of 15 members) established supervision on the progress of carrying out the accepted plan, and in November, 1959 discussed the progress on the introduction of the proposed measures regarding the mechanization and automation G. P. Malikov, the Deputy Director of the Technical Department for New Techniques read a report at the meeting.

The members of the Presidium, present at the meeting, revealed serious shortcomings in the way in which some points of the 5 year plan for the development of mechanization at the Works were carried out. It was established that some heads of shops and heads of project departments were responsible for delays and disarrangements in the completion of important measures. The meeting proposed to the Works Director that he should impose severe administrative penalties on the Head of the Project Department, Comrade Rutberg, and on the Head of the Steel-Melting Shop, Comrade Porada, and advised the Chief Engineer and the Administration of the Works, that they should take appropriate measures for a speedy elimination of these shortcomings.

At a special meeting the Presidium of the Council heard a report by Comrade Rutberg on the work of the Project Department. The shortcomings in the work of the Project Department were subjected to strong criticism, and ways of eliminating these shortcomings were proposed. The Presidium of the Productivity Council reprimanded Comrade Rutberg very severely. The Chief Engineer of the Works was instructed to call a meeting of the Productivity Council of the Project Department. On their part the Trade Union Committee achieved some improvement in the work of the Trade Union Branch in this department.

The result of these actions were to be seen before long. The introduction of organizational and technical improvements contained in the plan was speeded up considerably and some of them were completed ahead of schedule.

The replacement of old hammers was envisaged for 1961. The Forge Shop operators however decided to carry out the replacement earlier. By now, one hammer had already been replaced by a more powerful hammer of a modern design. Two annealing furnaces have been built in the Heat Treating Section of the Heat Treating and Rolling Shop one year ahead of schedule. The mechanization of the steel pressing operations was planned for 1963 but owing to the efforts of the personnel of the Chief Mechanic's Department, the mechanization had been carried out in the current year and for this purpose a 600-ton hydraulic press has been built.

In addition, a detailed plan for each year is worked out on the basis of the 5 year plan. For instance, in the second year of the 7 year plan it has been planned to complete 95 measures relating to the technical and economic improvements of operations, the introduction of new methods, an improvement in processes, the mechanization and automation of production, the modernization of existing equipment, an improvement in the quality of steel, a reduction in metal losses, an improvement in safety, in working conditions, and in the workers' standard of living.

In preparation for the July Plenary Session of the Central Committee of the KPSS the workers at the "Dneprospetsstal'" Works completed several undertakings ahead of schedule: for example, an automatic finishing line has been put into operation at the Steel Rolling Shop, and a plant for the electric-remelting of high quality steel under slag has been built and put into operation at the Steel Melting Shop.

The Permanent Productivity Council organizes a check on the progress and completion of the saving plan for nonferrous and ferrous metals, other materials, and electric power.

The Productivity Council assists the innovators and planners in the realization of their proposals. For instance, the proposal of combined team of innovators and inventors led by G. K. Smetanin regarding the application of sectional frames during cold repairs to electric furnaces was delayed for a long time, until finally it was approved and accepted at a meeting of the Productivity Council which made the heads of the Steel-Melting Shops and the Chief Mechanic of the Works responsible for the realization of this proposal. At first this proposal was put into practice at one of the Steel-Melting Shops during the major overhaul. As a result of this, owing to the time saved during the furnace repairs, thousands of extra tons of electric steel were produced. The introduction of this single proposal made it possible for the Works to achieve savings of hundreds of thousands of rubles annually.

The realization of other proposals is also bringing remarkable results. Thus, for instance, equipment for the electromagnetic mixing of liquid steel during the melting process has been installed and put into operation at furnaces of one of the Steel-Melting Shops, highly efficient polishing machines for dressing billets and sections have been installed and mastered, investigations aimed at an improvement in the quality of several steel grades have been carried out, an original polarograph apparatus for the determination of the content of nonferrous metals in refractory alloys has been adopted, the production of new steels and the rolling of shapes from stainless steel has been adopted, and so on. The plant for the remelting of steel under a slag layer, developed by the E. O. Paton Institute and introduced in cooperation with specialists at the Works, is operating very satisfactorily.

Apart from concrete straight-forward production problems, the Productivity Council also considers other urgent and important problems, such as: the quality of the product and the completion of orders (24 new suggestions have been accepted), the state of the ventilation equipment and measures aimed at a further improvement in safety (35 suggestions have been accepted), the preparation of shops for winter conditions, the plan for organizational and technical measures regarding the completion of the production schedule of the first year of the 7 year plan, the 5 year plan for the mechanization and automation of industrial processes, and so on.

The work of the Presidium is of great importance for the successful operation of the Works Productivity Council. The selection by the Presidium of urgent topics of interest to workers and a careful preparation of problems for discussion provide a guarantee for the successful operation of the Council and ensure the attendance of members and their participation in the proceedings of the Council.

As an example of the work of the Council Presidium at the "Dneprospetsstal'" Works, one could quote the preparation of the discussion on the problem of the fulfillment of the obligation undertaken by the personnel of the Works in the socialist competition to reduce losses due to defective products by 15%. This task was not carried out well at the Works, and at some shops the amount of rejects even increased; this disturbed the workers and the technical and administrative personnel. However, the solution of the problem of reducing the amount of defective product depended to a great extent on the work of other shops, main shops as well as auxiliary ones. Only the general coordinated and combined efforts of the personnel of all sections could produce the desired results. On the suggestion of the workers, the Presidium of the Productivity Council at its current meeting decided to bring up the problem of the quality of the products for general public consideration and discussion, that is, at a meeting of the Productivity Council.

For the preparation, organization,and collection of information and for the checking of the actual situation, the Presidium set up three commissions: one for steel-melting production, one for rolled-steel production, and one to review the information and prepare new proposals. The commissions were composed of experienced steel melters, rolling mill operators, engineers from the Central Works Laboratory, the personnel of the OTK (Technical Control Department), and the representatives of the Works Management.

The members of the Commissions visited the shops, had talks with workers and technical personnel, consulted them, and prepared a proposal of measures to be taken. After careful preparation the Presidium called a meeting of the Productivity Council and invited active trade unionists, members of Shop Productivity Councils, shop leaders, leaders of departments, secretaries of Party Branches at the Shops, and the chairmen of the Trade Union Committees of the shops. The meeting was attended by about 150 men. The report of the Chief Engineer on the quality of the product and on the fulfillment of orders was followed by a lively discussion. The contributors expressed their views as to what hampers high quality work of electrometallurgists, made their suggestions aimed at the elimination of the present shortcomings — pointed out the necessity for drying the oxygen received, improving the quality of the lime, using chromemagnesite bricks in boxes, improving the temperature measurements of liquid steel by immersion thermocouples, etc.

The meeting proposed 24 measures which were subsequently accepted by the Management for adoption and announced in the Works instructions.

The Presidium also carried out a great deal of work during the discussion of the state of ventilation equipment at the Works and the measures required for a further improvement in safety. In the course of the preparations for the discussion,medical officers of the Works, the Town Health Stations,as well as the staff of the Trade Union Organizations were invited to collaborate, which was of great help in this work. The personnel of health departments studied the conditions at the shops carefully and made valuable suggestions. The fight for the adoption of these measures called for special efforts on the part of the Council and introduced new vigor in the Councils' activities. For the elimination of the shortcomings the Council accepted 35 suggestions which subsequently were put into practice.

By keeping constantly in touch with persons responsible for the adoption of new proposals with the administration and with the authors of the suggestions, the Presidium of the Productivity Council, the Productivity Commission of the Trade Union Works Committee,and the Trade Union Shop Committee watch the progress toward the fulfillment of the proposed measures and the adoption of the suggestions of the workers carefully, and find who is responsible for any delays and assist in the elimination of any shortcomings.

In February, 1960, the Productivity Council considered the problem of speeding up the completion of orders and has already achieved some improvement in this respect.

In accordance with the plan, approved by the Trade Union Committee this year, it is envisaged that the meetings of the Council shall discuss the problem of improving the quality of the products and carrying out a general review of production methods, mechanization of labor consuming processes, modernization of the Works, preparation of the shops for operation during the autumn and winter periods, and that in November the progress

toward the completion of organizational and technical measures accepted for the second year of the 7 year plan shall be reviewed.

Through the Permanent Productivity Councils of Shops and Works at the "Dneprospetsstal'", about 2000 workers have been brought in to participate in production management. This is an impressive force.

The Trade Union Works Committee will continue to make every effort to extend and improve the activities of the Productivity Councils.

SIGNIFICANCE OF ABBREVIATIONS MOST FREQUENTLY ENCOUNTERED IN SOVIET PERIODICALS

FIAN	Phys. Inst. Acad. Sci. USSR.
GDI	Water Power Inst.
GITI	State Sci.-Tech. Press
GITTL	State Tech. and Theor. Lit. Press
GONTI	State United Sci.-Tech. Press
Gosénergoizdat	State Power Engr. Press
Goskhimizdat	State Chem. Press
GOST	All-Union State Standard
GTTI	State Tech. and Theor. Lit. Press
IL	Foreign Lit. Press
ISN (Izd. Sov. Nauk)	Soviet Science Press
Izd. AN SSSR	Acad. Sci. USSR Press
Izd. MGU	Moscow State Univ. Press
LÉIIZhT	Leningrad Power Inst. of Railroad Engineering
LÉT	Leningrad Elec. Engr. School
LÉTI	Leningrad Electrotechnical Inst.
LÉTIIZhT	Leningrad Electrical Engineering Research Inst. of Railroad Engr.
Mashgiz	State Sci.-Tech. Press for Machine Construction Lit.
MÉP	Ministry of Electrotechnical Industry
MÉS	Ministry of Electrical Power Plants
MÉSÉP	Ministry of Electrical Power Plants and the Electrical Industry
MGU	Moscow State Univ.
MKhTi	Moscow Inst. Chem. Tech.
MOPI	Moscow Regional Pedagogical Inst.
MSP	Ministry of Industrial Construction
NII ZVUKSZAPIOI	Scientific Research Inst. of Sound Recording
NIKFI	Sci. Inst. of Modern Motion Picture Photography
ONTI	United Sci.-Tech. Press
OTI	Division of Technical Information
OTN	Div. Tech. Sci.
Stroiizdat	Construction Press
TOÉ	Association of Power Engineers
TsKTI	Central Research Inst. for Boilers and Turbines
TsNIÉL	Central Scientific Research Elec. Engr. Lab.
TsNIÉL-MÉS	Central Scientific Research Elec. Engr. Lab.-Ministry of Electric Power Plants
TsVTI	Central Office of Economic Information
UF	Ural Branch
VIÉSKh	All-Union Inst. of Rural Elec. Power Stations
VNIIM	All-Union Scientific Research Inst. of Meteorology
VNIIZhDT	All-Union Scientific Research Inst. of Railroad Engineering
VTI	All-Union Thermotech. Inst.
VZÉI	All-Union Power Correspondence Inst.

Note: Abbreviations not on this list and not explained in the translation have been transliterated, no further information about their significance being available to us - Publisher.